THE MARKETING AND DISTRIBUTION SYSTEM FOR FRESH FISH IN SOUTH WEST ENGLAND: MODELLING THE EFFECTS OF SUPPLY VARIATION

John Edward Slaymaker,
BA, MA

Submitted to the Council for National Academic Awards in Partial Fulfilment for the Degree of Doctor of Philosophy.

Sponsoring Establishment:
Plymouth Polytechnic,
Plymouth Business School.

Collaborating Establishment:
University of Exeter.

April, 1988.

CONTENTS

Chapter			Page

LIST OF TABLES

LIST OF FIGURES

Page

CHAPTER 9

ACKNOWLEDGEMENTS

I would like to thank everybody who has helped me undertake this research project and although there is not room here to mention everybody, there are individuals I would like to thank by name. Firstly, I would like to express my gratitude to my main supervisor, Ian Chaston, for his encouragement and advice throughout: to my second supervisor, Richard Gray, for his advice especially in the early stages.

I would also like to thank my colleagues at Plymouth Polytechnic, including: the Economics Group, especially Nick Wiseman and Paul Nicholas, for the interest that they showed and constructive advice they gave.

I am further indebted to many people within the fishing industry in Devon and Cornwall for sparing me valuable time and for giving me practical opportunities to learn about this fascinating industry. In particular I would like to thank Colin George of the Ministry of Agriculture, Fisheries and Food, for providing me with information concerning the local industry and specific data. Secondly, many thanks are due to Steve Farrar and Hugh Symonds for allowing me to work for their company and giving me, in the process, the opportunity to develop my understanding of the onshore industry.

ABSTRACT

THE MARKETING AND DISTRIBUTION SYSTEM

FOR FRESH FISH IN SOUTH WEST ENGLAND:

MODELLING THE EFFECTS OF SUPPLY VARIATION

by

John Edward Slaymaker

The distribution system in the fishing industry has attracted little attention from academics in comparison to the catching sector. This realisation came in the early 1980's with questions being raised about system efficiency and the identification of problems. A lack of understanding of the distribution system led to various calls for an investigation.

This research builds on existing understanding by identifying the distribution system in Devon and Cornwall and develops a modelling framework with forecasting properties within which distribution system problems can be analysed.

A review of the marketing and distribution literature reveals that system efficiency and the impacts of changes in external conditions are important areas for study. The literature also reveals that few attempts have been made to develop analytical and conceptual modelling frameworks that enable the study of these phenomena in existing distribution systems. Attempts that have been made suffer from conceptual and data problems.

The research identifies the major features of the fresh fish distribution system, especially the structural determinants including lack of standardisation and variability of supply. Studies of the system in the United Kingdom and overseas are found to be descriptive, concentrating upon trends and past problems. Few modelling approaches have been used or developed.

The system in Devon and Cornwall is identified through interview techniques and presented in quantitative terms. From an identification of the system, it is determined that a model should focus on the port merchant sector and have the ability to explain and forecast the effects of supply variation.

Econometric methods are used to develop a model with exogenous supply and seasonality characteristics which when combined with sample data on costs and pricing provides a method of analysis and forecasting. The research discusses the wide range of applications possible with the model developed .

CHAPTER 1

INTRODUCTION

Historically, interest in the fishing industry, especially in the United Kingdom, has been confined to the catching or offshore sector. By comparison, the onshore sector, primarily the institutions such as fishmongers, inland wholesale markets and port merchants which comprise the marketing and distribution system, has received very little attention. The past ten to fifteen years have seen many important developments in the international and national fisheries regime, developments which have had profound effects upon the fishing industry. For the most part, the problems and changes facing the fishing industry resulting from the new fisheries environment have been discussed in terms of their implications for the catching sector.

However, in more recent years there has been a growing realisation that if the fishing industry as a whole is to adjust successfully to the changed situation in which it finds itself, then the problems facing the onshore sector need to be considered also. In particular, in the last four years, there has been a growing interest in the overall marketing of fresh fish in the United Kingdom. This interest has taken the form of identifying problems and making recommendations to improve the marketing of fresh fish in such a way that the onshore sector of the fishing industry can make a larger contribution to the future viability of the overall fishing industry.

Within this growing interest in the onshore sector of the fishing industry and in particular the marketing of fresh fish, one particular problem became apparent. This was a distinct lack of knowledge of the distribution system by which fresh fish passed from production to consumption. Very little was known about the combination of institutions through which fresh fish passes before being purchased by the final consumer; nothing was known about the detailed functioning of the distribution system; whether that system was efficient or not, or what had been the effect of the changing fisheries environment on that system. These problems led to numerous calls from those involved with the management of the fishing industry for some kind of investigation into the distribution system for fresh fish in the United Kingdom.

This thesis is an attempt to answer such calls and provide a fuller and more meaningful understanding of fresh fish distribution systems than has hitherto been attained. The particular aims of the project are two-fold: firstly, to identify the existing distribution system for fresh fish that operates in the South West of England (Devon and Cornwall); and secondly, from a descriptive understanding of that system, to develop a quantitative model which has the ability to explain and predict the effects of various exogenous changes upon that system. The project is important for a number of reasons. Firstly, it identifies the distribution system in the South West, which previously has not been achieved; secondly, it provides a fuller understanding of the important relationships within the system; and finally through the development of a quantitative model with predictive properties, it provides a planning tool of considerable usefulness to those concerned with the management of various aspects of the fishing industry.

The study is concerned with the distribution system originating in Devon and Cornwall, a distinctive and unified region of the United Kingdom fishing industry. The study also concentrates upon fresh fish and not frozen due to the absence of the latter from the indigenous fishing industry. In addition, only demersal fish (bottom living species such as cod, plaice and lemon sole) and shellfish species are considered. Pelagic species (middlewater shoaling species such as mackerel and herring) are not considered for reasons given in Chapter 5.

Chapter 2 discusses the role of distribution in marketing and establishes the particular importance of the distribution system within the overall marketing process. Much of Chapter 2 is drawn from "Approaches to the Study of Marketing and Distribution Channels" (Slaymaker, J.E., 1983) published in the Spanish economic journal "Gestion Cientifica" of the University of Madrid. It reviews and evaluates those theories and models put forward to assist in evaluating the efficiency of a given distribution system and the effects of various changes upon a distribution system. Here it is revealed that apart from L.P. Bucklin's "Theory of Distribution Channel Structure" (1966), the whole area of distribution has received little attention within marketing. Certainly, it is found that few models have been developed to assist in studying real world distribution system problems in a meaningful manner.

Chapter 3 discusses the particular importance and distinctive characteristics of the distribution system for fresh fish emphasising the determinants of the system existing in the United Kingdom.

Chapter 4 reviews both United Kingdom and overseas studies of fish distribution systems. It is found here that the majority of studies are descriptive, providing little information on the detailed functionings of the system. Several studies have attempted to develop models of distribution systems in order to increase the understanding of such systems and also to predict the effects of various changes. Most of these studies suffer from serious problems.

Chapter 5 discusses the research methods utilised in order to arrive at a descriptive understanding of the distribution system for fresh fish in the South West. An overview and discussion of the system is presented, concentrating on the most important aspects, mainly the port merchants. Chapter 5 also indicates the way in which a quantitative model of the distribution system will develop in later chapters and also identifies those characteristics of the system to be studied, including the cost and revenue structures of the port merchant system, the objectives of the model and the methods to be used.

Chapter 6 begins the model development in earnest by examining econometric methods of estimating demand equations. Here, a special form of demand model is derived and specified which if successfully estimated will allow the examination and forecasting of changes in supply upon the major cost to the system, the purchase price of major demersal species and the species group treated as a whole. This chapter also discusses the issue of seasonality and includes it as a major variable in the various models as an explanatory variable.

Chapter 7 presents the results of the model estimations. In general, the specified models perform well with one or two exceptions. In order to further improve on the models already estimated, new variables and new methods of estimation are introduced and tested. This chapter concludes with an examination of the models' forecasting abilities: different versions of models for the some species are evaluated in forecasting terms to determine the most accurate models.

Having completed this, Chapter 8 moves on to develop a cost and pricing model of the port merchant sector. It is shown how the representative cost sample data can be developed into a functional cost model of port merchant operation. Similarly, this chapter develops and justifies a pricing model to allow for the determination of revenues in the system. This chapter concludes by showing how the different components of the model can be brought together to provide a disaggregated picture of the financial position of the port merchant sector in 1982 (the last year at the time of writing for which data was available). Also of importance, this chapter shows how the model can be used to determine breakeven levels of supply for each month.

The thesis concludes in Chapter 9 by examining the implications, achievements and applications of the model. It shows how the model can be used in a partial manner to examine a variety of influences upon port merchant profitability thus providing a deeper understanding of this important level of the distribution system. It is argued here that the model has a wide range of applications in its existing form and serves as a principle with general applications to systems elsewhere. The thesis concludes with indications of likely beneficial areas of future development.

CHAPTER 2

THEORIES AND MODELS OF MARKETING AND DISTRIBUTION SYSTEMS AND THEIR APPLICATIONS

2.1 The Role and Nature of Distribution Systems in Marketing

Marketing is comprised of a great many and varied activities. It is for this reason that definitions of marketing tend to be very broad. A general definition has been put forward by Kotler (1980):

> "Marketing is human activity directed at satisfying needs and wants through exchange processes."

Definitions such as this give some idea as to the overall nature of marketing; however, greater insight into the marketing process is given by Mallen (1967), to whom the purpose of marketing is :

> "To advise production on what and how much to produce, based on consumer needs, and to direct the flow of goods to users and resellers."

This definition begins to indicate the great many activities that constitute marketing. Most textbooks (for example, Mallen, B.J., 1977) generally agree that marketing includes or is directly involved in personal selling, advertising, sales promotion, packaging, product development, purchasing, planning, pricing, marketing research, transportation, storage, inventory, wholesaling and retailing.

A glance at these various activities will indicate the vast range of marketing occupations present in an economy; occupations which engage a sizeable proportion of the workforce and a large share of the total business activity within an economy. An indication of the importance of the costs incurred by marketing activities is given by Mallen (1972) for the Canadian economy where he estimates that in general, 50% of a product's final cost to the ultimate consumer can be attributed to the various activities outlined above.

Implied in the brief discussion of marketing above, is the notion that in the process of exchange, points of production are separated from points of consumption in some way or other. McInnes (1964) has suggested five major dimensions along which producers and consumers are separated. Firstly, and perhaps most obviously, a spatial discrepancy exists between producers and consumers. A very small proportion of an economy's goods and services are consumed or purchased at the point of production; furthermore, only a very small amount are purchased by the ultimate consumer directly from final producers. The majority of goods and services must overcome the physical distances that exist between producers and the final marketplace. A second separation may be termed temporal. This discrepancy arises because of the lack of synchronisation between the production and consumption of goods and services, yet this discrepancy must be overcome in order for supplies to be available to consumers at times when they are demanded. Thirdly, there is also a perceptual discrepancy between producers and consumers. This two-way separation exists because consumers do not know about supply sources and producers do not know where consumers are. A fourth discrepancy is that of ownership; an exchange of goods is not made until the title of ownership has been passed from producer to consumer. The final separation suggested by McInnes (1964) is that there is a discrepancy of values placed upon goods and services by producers and consumers.

In addition to the various separations mentioned above, there also exists a discrepancy between the assortment of goods and services generated by the producer and the assortment demanded by the Consumer (Alderson, W., 1954). This discrepancy results from the fact that manufacturers typically produce a large quantity of a limited variety of goods, whereas consumers usually desire only a limited quantity of a wide variety of goods.

Clearly, if the process of exchange between producers and consumers is to be successful, then the various discrepancies need to be closed. It is the distribution channel/system that performs many of the functions required to bridge the various gaps that exist between producers and consumers. Even for a single product, these functions are seldom performed by one firm, but rather by a sequence of firms. The particular sequence of firms that performs the various marketing functions is usually termed the marketing or distribution channel. Where a firm or industry operates a series of different channels of distribution for the same product or range of products, this is termed the marketing and/or distribution system.

A formal definition has been postulated by Bucklin (1966) :

> "A channel of distribution shall be considered to comprise a set of institutions which performs all the activites (functions) utilised to move a product and its title from production to consumption."

The all encompassing nature of the above definition tends to be a reflection of the fact that while most marketing scholars agree that distribution channels are sets of institutions which perform functions in order to facilitate flows, very little agreement can be found in the interpretation of these phenomena.

For example, there exists considerable debate in the literature as to which flows through the distribution channel should be included in the definition. Early authors such as Butler (quoted in Bucklin, L.P., 1966) considered the primary flow to be that of ownership or title. Some authors considered that more flows were necessary in order to encompass the work of marketing: for example Vaile, Grether and Cox (1952) suggested the eight flows of physical possession, payment, ordering, ownership, negotiation, financing, promotion and risking. In general most authors tend to consider the twin flows of product and title to form a sufficient basis for the study of distribution channels.

Similar disagreement exists in the literature as to the specific functions which should be included in a channel definition. Where the distribution channel is viewed primarily as the physical conduit for the passage of goods, one tends to find emphasis upon the functions of transportation, storage and inventory. Those who view channels in terms of the flow of products and title often include additional functions. For example Kotler (1980) lists the functions of contact, merchandising, pricing, propaganda, physical distribution and termination. While different writers postulate different functions, there do appear to be a number of functions common to the literature. Most studies tend to refer to the transportation function in order to bridge the spatial discrepancy; the ownership, inventory, sorting, communication and pricing functions are commonly mentioned.

In the same vein, the institutional characteristics of distribution channels are a subject of contention. Some disagreement exists as to the length of the distribution channel. For example, the traditional view tends to focus on intermediary institutions such as wholesalers and retailers to the exclusion of producers and consumers (for example : Alderson, W., 1957).

Other authors (for example: Davidson, W.R., 1970) argue that both manufacturers and consumers are inextricably linked to the marketing process and should be included in any institutional definition of a distribution channel. Other authors (Bucklin, L.P., 1966) argue that only the manufacturer should be included along with intermediary institutions due to the difficulty of distinguishing between the costs of marketing and the costs of production. The majority view, however, is that only intermediary institutions should be included (Gattorna, J.L., 1978).

The other major area of institutional disagreement relates to the type of institutions which should be included. To a large extent, this issue is dependent upon one's view of the flows and functions to be included. The major question here appears to be whether institutions who do not take title to a product should be included within a channel definition. Some authors (for example; Beckmann, T.N. and Davidson, W.R., 1967) argue that institutions such as transport hauliers, warehousing and advertising agencies who generally do not take title to a product should not fall within the institutions included in a channel definition. Others, (for example, Bucklin, L.P., 1966; McCammon, B.C. and Little R.W., 1965) have argued for the inclusion of non-title taking institutions.

In general then, distribution channels exist in terms of institutions who perform a variety of marketing functions to facilitate the flow of products and usually title in order to bridge the various separations that exist between producers and consumers. While agreement on the general role and nature of distribution channels can be found, it is somewhat more difficult to arrive at specific definitions of their form.

2.2 Approaches to the Study of Distribution Systems

Studies of distribution channels/systems may be classified in two ways. Some take a micro-view orientated to the perspective of the individual firm. Such studies are essentially managerial in nature and are concerned with the types of relationships that firms must establish with other institutions in order to successfully market a product. Typical issues involved in this approach concern the number and type of intermediaries to be utilised by the firm, the activities that a firm should share with others and how to manage and plan relationships with other firms. The criterion upon which decisions are based is usually the maximisation of the long run interests of the firm.

A second approach to the study of distributions systems, and the area of concern of this thesis, may be termed the macro-perspective. This view focuses upon the distribution system, or sections of it, as a whole. The perspective adopted is either from the point of view of the interests of the industry as a whole, or from the perspective of the consumer.

Within this macro-view, it is possible to identify three broad interrelated areas which are generally considered as important for study. Firstly, one has the area of distribution system identification, classification and measurement. Typical issues within this area concern the description and classification of the institutions and functions by which a product or products are marketed. Measurement in this context is typically in terms of the costs and profits accruing to the various intermediary institutions and the volume and value of products passing through institutions comprising a distribution channel or distribution system.

A second important area of study within the macro view concerns the performance of the distribution system. Many issues are important here; why a particular distribution system for a product exists, the operational characteristics of a system, and the evaluation of the performance of a system in relation to some criterion or other. Distribution system performance is discussed along several major dimensions. Distribution costs have long been considered a major aspect of system performance; similarly, profitability, productivity, responsiveness to change and stability are also considered important facets of system performance.

A third major area for study has been termed by Bucklin and Stasch (1970) as prediction. Within this area, is the study of the factors which affect distribution system performance and in particular the analysis and evaluation of internal and external changes upon the structure and functioning of distribution systems.

Studies of these three related areas at the macro-level have been undertaken in both empirical and theoretical terms. Most empirical studies are confined to the identification and description of distribution systems. However, the concern with distributional efficiency has led various studies to attempt to evaluate the performance of a given distribution system usually in terms of distributive cost.

As early as 1939, the Committee on Distribution of the Twentieth Century Fund in the United States published "Does Distribution Cost Too Much" (1939). The study was wide ranging covering many industries, and concluded that distribution did cost too much and on that basis was inefficient. The conclusion was reached primarily because there were many features of the distribution process :

"which reveal opportunities for savings: duplication of sales efforts, multiplicity of sales outlets, excessive services, multitudes of brands and unnecessary advertising."
(Stewart and Dewhurst, 1939).

This type of approach to assessing the efficiency of distribution systems, based upon description and value judgements is still common in the marketing literature today. A more recent example in a similar vein is the attempt to appraise the distribution channels for automobiles in the United States undertaken by Moyer and Whitmore (1976). The authors were concerned that while the distribution channels for automobiles had been described and recognised in terms of their great size and complexity, little attention had been devoted to a consideration of the overall effectiveness of the system. As with studies of this type, Moyer and Whitmore then proceed to draw up a list of criteria chosen to assess the distribution channels for automobiles in terms of whether the system satisfies the final consumer. The criteria chosen in this case, were outlet choice, product choice, financial costs, buying information, reliability, service, psychic costs and adaptability. The effectiveness of these criteria from the point of view of the final consumer is then discussed and judged according to whether the authors believe the system is effective. To give an example, Moyer and Whitmore discuss outlet choice from the point of view of the final consumer :

"For the purchase of a new car, most consumers seem to have an acceptable choice of competing dealerships in reasonably accessible locations. ..... In terms of outlet choice then, the marketing channels for automobiles seem to perform well."

At the macro-level, the areas of the efficiency of a given distribution system and the impacts of change upon distribution systems have long been recognised as important interlinked areas. However, it is doubtful whether descriptive empirical studies such as those above really constitute a satisfactory approach. For example, how can one evaluate the cost efficiency of a distribution system without some knowledge of whether the existing level of costs pertain towards some optimal minimal level of costs? Furthermore, descriptive studies do not explain why a particular distribution system structure gives rise to a particular cost structure. In order to assess distribution system efficiency, there is a need for theoretical and modelling frameworks which can explain why particular distribution system structures emerge and provide a benchmark level of operation with which the actual level of operation can be assessed. Similarly, in order to analyse the impact of internal and external changes upon the structure and functioning of a system, there is a need for modelling methodologies which explore the particular relationships in the system and allow one to draw quantitative conclusions. To see whether any frameworks have been developed at the theoretical level is the subject of the next section.

2.3 Theoretical and Conceptual Models of Distribution Systems

In 1965, Halbert (1965) wrote :

"The marketing channel as an area of study has led a strange existence. It is perhaps the only major concept in marketing not borrowed from another discipline, but it is perhaps also the least understood and examined area in the field."

Having argued in the previous section that distribution system performance and prediction are important areas for study, and also that these areas need to be studied within the framework of theory or models, it is somewhat surprising to find that Halbert's comments are still to a large extent true today with regard to theoretical studies of distribution systems. Very few theories or frameworks have been developed which have the ability of explaining and increasing our understanding of the complex forces that shape the many different distribution systems that are found in the real world. As a result, very few models have been put forward within which one can satisfactorily study the problems of system performance evaluation and the quantitative analysis of change.

Considerations of distribution system efficiency have been an area of interest on the theoretical level. Rather than the development of theory which enables one to test system efficiency, much of the concern has been to theorise about the rationale for distribution systems in general, usually in terms of increasing economic efficiency. Stigler (1951), took a functional view of the firm in arguing that even if a firm was operating at a long run equilibrium level of output where marginal cost equals marginal revenue at the lowest point on the average cost curve, there might still be potential economies available. Stigler contends that further economies might still be possible through the delegation of a number of selected functions to external firms who are specialised in the performance of such functions. Thus, one can see that intermediaries may represent a source of external economies for producers and increase the economic efficiency of the process of exchange because they are able to perform the delegated functions at a lower cost per unit than the producers. Stigler also takes the analysis a stage further to attempt to explain why distribution system structures change over time by suggesting that as producers or other channel institutions grow, they may reintegrate the previously delegated functions and perform them at a comparable cost per unit themselves.

Another view, common in the literature is that intermediaries arise in the process of exchange because they increase economic efficiency by reducing the cost of transactions. A typical example found in many works (for example Stern and El Ansary; 1977) is the case where one has a number of manufacturers selling directly to a number of retailers. The number of transactions needed for each manufacturer to sell directly to each retailer can be considerably reduced through the introduction of an intermediary wholesaler. Each manufacturer now sells only to the wholesaler who then suppliers the retailers. This second system reduces the costs of transactions considerably.

This rather mechanistic institutional approach showing how the introduction of intermediaries increases economic efficiency has been conceptualised in different ways. Alderson (1954, 1957) builds on the ideas of Stigler and suggests that intermediaries appear in distribution systems to "smooth" the flow of goods and services. The major aspect of this smoothing process is that institutions, principally wholesalers, undertake various sorting functions in order to bridge the discrepancy of assortment mentioned in section 2.1. Alderson considered four processes to constitute the sorting function:

Firstly, **sorting out**, which is the breaking down of a heterogeneous supply into smaller homogeneous stocks.

Secondly, **accumulation,** which is the bringing of similar stocks together to form a larger homogeneous supply.

Thirdly, **allocation,** where a large homogeneous supply is broken down into smaller lots.

Finally, one has **assorting**, where assortments of goods are built up for use in association with each other.

Implicit in Alderson's approach is the idea that the performance of these sorting functions by wholesalers achieves scale economies.

A further aspect of the economic rationale behind distribution channels considered by Alderson is the opportunity to minimise costs through the routinisation of transactions. This principle revolves quite simply around the assertion that the cost of moving goods from one level of a marketing channel to another can be minimised if the transaction can be reduced to a routine operation. If factors such as frequency of payment, lot size, delivery and communication can be routinised, then it is argued that this will further increase the efficiency of transactions by reducing the costs of distribution.

While Alderson's ideas, based upon the distribution function solely in terms of sorting, primarily form a conceptual argument for the emergence of intermediary institutions in general, and certainly do not provide a theoretical basis capable of explaining why particular sequences of institutions develop, he does make some pertinent observations. For example, Alderson recognised that the need for the performance of different sorting functions would change between industries due to different conditions of supply and different products. Allied to the argument that the discrepancy of assortment induces specialisation into the distribution channel, one begins to see that the performance of different marketing functions for different products is likely to lead to different structural arrangements in different distribution channels.

Aspects of sorting and their relationship to the structure of distribution channels were also of interest to Vaile, Grether and Cox (1952). While primarily concerned with the whole area of marketing, they conceived "the core of marketing" to be the exchange and movement of goods among areas and between regions; in other words the marketing channel. Along the same lines as Alderson (1954, 1957), they saw the various sorting processes as crucial to the structure of distribution channels. To them, the specialisation of institutions and the integration or non-integration of enterprises in the system was seen to be a function of the various processes of collecting, sorting and dispersing of goods.

Within these early conceptual developments about the economic rationale for distribution systems was a growing recognition that not only did institutions appear because they increased efficiency through the specialised performance of various functions, but also that the necessity for the performance of different functions to some extent determined the various institutions which appeared in distribution channels.

Perhaps in recognition of this, some authors moved away from theorising about the distribution channel as a whole and concentrated on the rationale for particular types of institutions which appear in channels. To this end, Courtney (1961) was concerned that :

> "middlemen ... are too often looked upon by the general public as anachronistic appendages, useless leeches on the economy, adding cost but no value to the goods they handle".

Courtney rationalised the existence of the wholesaler in terms of the specialised functions that they perform. Firstly, wholesalers plan and co-ordinate local and national physical distribution; secondly they can economically cover a wide range of retail and industrial accounts; thirdly, they provide low-cost warehousing and storage facilities, and finally they are able to accept large shipments, thus achieving substantial transportation and paperwork savings. This approach to justifying the role of particular institutions within the channel on the basis of classifying the various functions they perform is common. In a similar vein Hall (1971) considered that wholesalers could perform various functions at a lower cost than anyone else. Among the functions listed are; the handling of stocks and the supply of credit facilities; the assortment of commodities into marketable shapes and sizes; the spreading of information and the physical transportation of commodities.

Retailing has come in for a similar treatment. Lazarus (1971) sees the role of the retailer as the interpretation of the demands of customers, searching for and stocking the goods customers want, and in the way that they want them.

Many of the theoretical and conceptual ideas about distribution channels, such as those above, are primarily concerned with the economic rationale for distribution channels, usually in terms of easing the cost of transactions and the external economies of scale available from the performance of functions by specialised institutions. Certainly the ideas discussed so far do not throw any light on how distribution channels function or what constitutes an acceptable level of performance.

Mallen (1973) is one of the few writers who adopts the functional rationale for distribution channels and attempts to develop a conceptual approach to channel organisation and performance. Mallen adopts the conventional view that the performance of the various marketing functions can be allocated in different ways to different institutions. He further argues that the functions will be allocated in such a way which creates greatest consumer satisfaction or greatest profit to the channel members. He further argues that should any member of the channel see an opportunity to change the functional mix of the channel in order to increase his profits by reducing his costs, he will attempt to do so. If he is successful, and the change in the functional mix is permanent, then Mallen argues that this will lead to changes in the institutional structure of the channel. According to Mallen, change in the distribution channel can be anticipated along four dimensions: firstly, the length of the channel in terms of the number of institutions; secondly, the number of channels; thirdly, the types of middlemen that will evolve; and finally, the number of middlemen thalt will evolve at each level.

In essence, Mallen views the distribution channel as a perfectly informed adaptable entity whose primary concern is to achieve economic efficiency in terms of minimising costs. Change in the distrtibution channel is viewed solely in terms of greater efficiency through his concept of "functional spin-off" leading to lower costs and changes in channel structure.

While Mallen's ideas are somewhat simplistic, he is one of the few authors to attempt to theorise about the forces behind distribution channel performance and how changes affect performance. While Mallen has undoubtedly advanced and stated more explicitly some of the earlier ideas, it is doubtful whether this highly abstract and general theory has any predictive value, as he himself feels. For example, it is very difficult to envisage the exact nature of changes in the distribution channel, primarily because Mallen does not explicitly consider the functions and institutions involved. It remains a very general principle.

While most of the channel theory is concerned with channel functions and institutions, some authors have attempted to conceptualise the distribution channel in different ways, particularly stressing the systems aspects.

For example, Breyer (1949) was interested in the affinity and relationships between institutions. He regarded the distribution channel as analagous to an electric circuit, whereby the current flows between positive and negative poles. The essence of marketing channels he perceived to be flows of goods, orders and payments and title between sellers and buyers. To Breyer, these flows were forced through the system by imbalance between supply, the positive pole and demand, the negative pole. The functions of contact and negotiation established the market circuits, and the final transaction closed them. While a somewhat simplified approach, it still remains one of the few attempts to conceptualise about the way a distribution channel operates.

Aspinall (1958) was another author who stressed the systems aspects of channels, and in contrast to Breyer (1949) he also considered channel structure explicitly. From the point of view of this discussion, Aspinall is particularly interesting as he attempted to develop a theory which was able to "explain facts and guide further investigation". The central tenet of this theory was that it was the characteristics of goods which determined not only the most appropriate channels of distribution, but also the most appropriate form of promotion.

Aspinall identifies five major characteristics of goods;: firstly, there is the replacement rate, which is the rate or frequency at which a good is purchased and consumed by users; secondly, one has the gross margin; thirdly, one has adjustment which is defined as "the services applied to goods in order to meet the exact needs of the consumer"; a fourth characteristic is the time of consumption; which is simply the time taken to consume the particular good in question; finally, one has searching time, which is the "measure of average time and distance from the retail store". A critical factor considered by Aspinall, is that the replacement rate is inversely related to the other characteristics. The example he quotes is bread. Bread is classified as a product with a high replacement rate, yet has a low gross margin, a short time of consumption, very little "adjustment" is needed for bread and it is a relatively accessible product with a low searching time. Aspinall quotes that a product such as a grand piano would have the opposite characteristics; a low replacement rate, a high gross margin, a long period of consumption, high amount of adjustment and a high searching time.

Aspinall's prime contention is that goods with high replacement rates, low gross margins and so on will need to go through long distribution channels consisting of at least one intermediary, while goods with the opposite characteristics will go through direct channels. A parallel part of Aspinall's theory is that goods which flow through long channels will require "broadcast" widespread promotion, as they are purchased frequently and from many sources. Goods passing through direct manufacturer to consumer channels require "closed circuit" or more specific and infrequent methods of promotion.

Aspinall's ideas are interesting for several reasons. Rather than regarding the distribution channel as a closed system, there is a recognition here that consumer demand is reflected in the various characteristics of a product. Implicit also, is the assertion that functions are necessary in determining various characteristics of a product, and that these functions determine the nature of the structure of the distribution channel. While Aspinall attempts to develop a rather general theory which importantly recognises that the product and its various attributes help to determine a distribution channel structure, it does not go as far as becoming a theory of distribution channel performance, rather it is a statement of channel characteristics, and does not allow for the evaluation of changes in these characteristics upon the structure of a particular distribution system.

The lack of an adequate theoretical framework within which to study the distribution system problems of performance and the effects of change were of special concern to one writer. L.P. Bucklin (1966) was particularly concerned that whilst most writers recognised the outward attributes of a distribution channel, very few theoretical or conceptual frameworks had been developed within which real world distribution channel problems could be studied.

In particular, he sought to develop a model which would have three principal usages.

Firstly, the model could be used to explain why a particular disbtribution channel/system for a product existed.

Secondly, the model, whilst recognising that intermediaries arise for efficiency reasons could be used in evaluating the efficiency of a given level of distribution channel performance.

Finally, and perhaps most interestingly, Bucklin sought to develop a model which had the ability to analyse how changes in economic conditions may alter and affect real world distribution channels.

In pursuit of these aims, Bucklin (1966, 1967a, 1967b, 1970) developed a general cost performance model of distribution system operation, an overview of which is presented below.

Bucklin's model, and its components, are developed within the context of static equilibrium and micro-economic theory of the firm. Predictions are drawn from hypotheses concerning the costs of performing marketing activities (functions), the nature of the services provided by these activities, and the nature of the demand for such services from the final buyer in the system. In the long run, and under reasonably competitive conditions, Bucklin argues that the interactions among these three basic forces will move distribution system structures to an equilibrium position, a condition from which no member of the system can beneficially leave.

Within Bucklin's general cost performance model, the distribution channel is represented by two major interacting subsystems; firstly, the final buyer such as the final consumer; and secondly, the commercial system consisting of all the institutions other than the final buyer. The model is directed to the final buyer's demand for both some particular product and for marketing services associated with the delivery of that product. The final buyer has the choice of performing these services himself, or purchasing them from the commercial institutions within the system.

One of the basic premises of the model is that when these services are purchased, they are regarded as outputs[1] of the commercial system in addition to the product itself. The greater the level of services purchased by the consumer, the higher the outputs of the commercial system and the higher the money cost to the final consumer. Conversely, the more substantial these outputs, the lower is the personal cost to the buyer in terms of time, effort and money.

Bucklin (1970) argues that this perspective rests upon the argument that the distribution channel is more than just a physical conduit whose only output is some quantity of goods, and also that consumer demand reflects the characteristics of the good as well as the good itself. The fundamental assumption of the general cost performance model is that the structure of the distribution system is highly sensitive to the level of service outputs provided. The various possible sequences of institutions, establishments and functions are not equally well suited for providing all different levels of service outputs. To Bucklin then, the structure of a distribution system is regarded as a function of output.

---

1. The particular outputs considered by Bucklin will be discussed in more detail at a later point.

Under competitive conditions, it is held, the institutions within the commercial system will organise themselves to provide the desired level of consumer services at the minimal cost possible. This point of equilibrium may also be defined as the least possible cost of operation for both the commercial system and the final consumer. This normative construct is the key point of the overall model.

While the above discussion represents a general overview of Bucklin's model, in order to gain a fuller understanding and be in a position to evaluate its usefulness, the mechanics need to be explored in more detail.

The conceptual framework developed by Bucklin is best stated in terms of a set of simultaneous equations. The first equation comes from the commercial sector of the distribution channel and represents the costs incurred by these institutions for their outputs. Following Bucklin, it can be stated :

$$Tc = f, (0_1, 0_2, \ldots . 0_r, N) \quad (1)$$

where :

Tc = the per unit product cost to the commercial system.

0i = the level of service of the ith output of the 1 to r outputs.

N = the average number of product units purchased by the final consumers in the market over some given time period.

In a similar vein, the final buyer or consumer sector is represented by similar equation which represents the costs to the final buyer of personally performing marketing services: it can be stated:

$$Tb = f_2 (0_1, 0_2, \ldots \ldots 0_r, N) \quad (2)$$

where :

Tb = the per unit marketing costs incurred by the final buyer.

0i = the level of service of the ith output of the 1 to r outputs.

N = the average number of product units purchased over some given time period.

In addition to the buyer cost function; Bucklin also includes a demand equation to reflect the buyer's willingness to purchase the product as related to the items price. This equation takes the traditional form of :

$$N = f_3 (P) \qquad (3)$$

where :

N = the average number of units purchased over some given time period.

P = the real price of the product unit.

Bucklin then closes this system of equations by means of a cost price identity. This identity makes two basic assumptions which give the model its normative characteristics. The first of these is that the costs of the commercial system will be equal to the price that the consumer pays this sector. Secondly, to the final consumer, the real price he pays is not only the figure quoted by the commercial system, but his estimate of the costs of marketing that he himself incurs. The cost price identity takes the form:

$$P = T_b + T_c \qquad (4)$$

where:

P = the real price of the product unit.

T_b = the per unit marketing costs incurred by the final buyer.

T_c = the per unit costs to the commercial system.

In addition to the assumptions noted above, Bucklin makes the further assumption, common in micro-economics, that competitive pressures upon the institutions of the commercial system are sufficient to cause them to operate without excess profits. In other words, the institutions operate in a perfectly competitive environment.

By the use of the cost price identity, Bucklin reduces the number of equations in the system in the following manner:

$$P = f_1 (0_1, 0_2 \ldots 0_r, N) + f_2 (0_1, 0_2 \ldots 0_r, N) \quad (5)$$

$$N = f_3 (P) \quad (3)$$

By further assuming that the marginal cost conditions are the same for **r** outputs in both the final buyer and the commercial sectors, the system then reduces to market supply and demand equations very similar to those found in micro-economics, as follows:

$$P = f_4 (N) \quad (6)$$

$$N = f_3 (P) \quad (3)$$

The nature of the relationships suggested by Bucklin between the two equations is not however the same as suggested by micro-economic theory. The demand function is the same, being inversely related to price: however, the supply function is rather different from that commonly suggested. In particular, the supply equation, (6), declines rather substantially with increasing purchases by the final consumer. This is due to the reductions in the costs of distribution, both to the buyer and the commercial sector, that result from economics of scale. Obviously, not only does the supply function fall to meet a minimum cost point, but also that after this point, the benefits from economies of scale disappear and the supply curve will approximate its more normal upward form.

Within Bucklin's general cost performance model, the basic presumption is that a relationship exists between the level of output of the distribution system and its structure. In particular, the principal hypothesis is that as the output of the system rises, the structure will become more elaborate. Put more generally, as the workload of the system increases, there will be an additional specialisation of activity as more functions, establishments and institutions are brought into the system to minimise costs.

Before going any further, it is necessary to specify the functions and service outputs postulated by Bucklin. He put forward the five functions of **communication, ownership, inventory, transit and production**. These various functions can be expressed operationally as a series of facilitative service outputs which represent the work load of the distribution channel in performing the above-mentioned functions. In all, Bucklin put forward four service outputs: **lot size, delivery time, market decentralisation and product assortment**.

Lot size is the number of units of the product that the final buyer purchases in a given order. Increases in lot size are inverseley related to commercial system output and cost, and directly related to consumer cost. It is argued by Bucklin that this service output can be seen as encompassing a considerable part of the sorting functions relating to the concentration and dispersion of product flows within the system, as originally discussed by Alderson (1954, 1957).

The service output of **delivery time** measures the period required for the final buyer to bring some product from the market into his possession. This time span not only includes the interval necessary for physical delivery of the product, but also any delays associated with the placing and processing of orders. As with lot size, increases in delivery time are inversely related to system output and cost, while consumer costs are directly associated.

The third service output specified by Bucklin, **market decentralisation**, may be said to exist when institutions such as wholesalers and retailers are spread evenly throughout space. In general, commercial system output and cost are increased with market decentralisation: principally because more business units, either firms or establishments, are necessary to conduct exchange under these circumstances.

In a later work, Bucklin (1970) adds a further service output, that of **product** diversity or **assortment** breadth. In the same manner as the other service outputs, the availability of broader assortments provides a convenience to the buyer and reduces his marketing costs. On the other hand, the provision of a broader assortment is likely to create additional commercial system costs.

As was mentioned earlier, the principal hypothesis of the model is that the higher the level of service outputs demanded by consumers, the more likely it is that intermediaries will be included in the system. For example, if consumers wish to purchase in small lot sizes, then there are likely to be numerous middlemen performing various sorting functions between producers and consumers. The same type of reasoning can be applied to all of the service outputs. However, as service outputs increase, costs will undoubtedly increase, and these higher costs will tend to be reflected in higher prices to consumers. Consumers are usually faced with the choice of dealing with distribution channel structures in which few service outputs are provided, but where prices are relatively low, or with systems where both service outputs and prices are high.

Bucklin argues that the final distribution system structure that emerges is a function of the desire of system institutions to achieve scale economies relative to each of the marketing flows or functions and the demand of consumers for service outputs of varying kinds. An optimal, normative, structure according to Bucklin, is one that minimises the total costs of the system (both consumer and commercial) by the appropriate adjustment of the level of service outputs.

Rather than remaining a general theory, much of Bucklin's original work (1966) remains a complex theoretical investigation of the many possible inter-relationships that one might find within a distribution system. The way in which functional structure relates to institutional structure is explored through the concept of functional substitutability, a refinement of Stigler's original concept (1951). The mechanics of the ways in which the different service outputs are related to institutional structure are explored through various concepts. Lot size is analysed in terms of various sorting functions and the need for various types of intermediaries. Delivery time is analysed through the concept of postponement-speculation, designed to examine temporal effects on the number and type of inventories in the system. Market decentralisation and product assortment are discussed largely through the concept of search and the various relationships between different aspects of these service outputs and the types of institutions needed to perform different functions to allow different levels of service outputs.

Bucklin develops his analysis of functions, institutions and service outputs as a basis for the major thrust of his work. He uses partial equilibrium analysis to devise various relationships between total system (commercial and consumer) costs and different levels of the various service outputs. In particular, he develops many theoretical cost models which show the minimum cost institutional structure for different levels of service outputs. From the many complex models developed, he draws a wide array of normative hypotheses concerning the different functions, number and type of institutions and length of distribution channels that would exist for different consumer characteristics and levels of service outputs, based on his normative assumption that institutions within the system are striving to reach the minimum cost point of channel performance.

The fact that Bucklin attempted to develop a theoretical framework which could show the most efficient channel configuration of institutions and functions based upon his normative criterion of minimal cost proved an obvious attraction for several authors interested in investigating distribution channel problems.

Bucklin himself with Halpert (1965) attempted to use some of the principles he himself developed in an investigation of the distribution channels for bulk cement in Northern California. In particular, they attempted to use the principle of postponement-speculation in relation to delivery time to determine the desirability of speculative inventories in the cement channels supplying the city of Sacramento. The major issue was to determine whether an indirect system of distribution with a speculative inventory represented a more normative efficient form of distribution than a direct delivery system with regard to different delivery times. Through a qualitative consideration of the costs involved, they found that an indirect system with a speculative inventory located in the city would offer faster delivery times at a higher cost to the commercial system than a direct delivery system from producer to consumer at longer delivery times. In addition, they argued that the benefits to the consumer in terms of faster delivery times through the indirect inventory system were outweighed by the extra costs incurred by the commercial channel. The total channel costs of the indirect system were greater than the direct system, albeit with slower delivery times. In effect, they argued that the predominant direct system was the most efficient normative channel of distribution.

The authors recognised various problems with their analysis, such as identifying and measuring costs, and the pricing practices of cement manufacturers clouding Bucklin's original theoretical cost structures. However, they still argue that the principles in the model form a valid basis for evaluating aspects of distribution channel performance; in particular determining the most efficient structures.

Sturdivant (1970) was concerned with the social role of distribution systems. Of particular concern here was the extent to which distribution has an important influence upon the lives of Negroes who live in ghetto areas in the United States. Sturdivant uses Bucklin's concept of the normative distribution channel to attempt to analyse problems in ghetto areas. He concludes that the overall distribution system does not approximate the normative[1] for the following reason :

> "Barriers to entry clearly represent one of the factors which have arrested the development of the distribution system at an inefficient stage."

---

1. Although Sturdivant does not discuss what the normative should be, he rather assumes that service outputs are not high enough.

Sturdivant sees the principal barrier to entry as being lack of competition, thus presenting the movement of the system towards the normative. He further concludes that the distribution system is inefficient in that the service outputs of market decentralisation, lot size and product assortment do not meet the needs of consumers. Without a detailed quantitative analysis of the costs and levels of service outputs demanded, it is difficult to see how these conclusions can be reached other than through value judgements. In fact, studies of this type bear more than a passing resemblance to the descriptive judgemental studies noted earlier.

Bucklin again set out to use his theoretical framework (Bucklin L.P. and Carman J.M., 1976) in an analysis of systems for the delivery of health care in the United States. In particular, he was concerned with seeing whether his theory would :

> "help in analysing and perhaps even predicting performance in some proposed new systems for the delivery of health care".

In order to facilitate the analysis and evaluation of different structural arrangements for the delivery of health care, Bucklin and Carman were forced to ignore many of the features of the real world, such as changes in demand, technology and political control. While Bucklin and Carman feel that they are able to evaluate different proposed structures in terms of providing consumer satisfaction and system performance, the paper has been criticised in a discussion by L.W. Stern and F.D. Sturdivant (1976). In particular, they felt that the model of the health care system ignored many of the relevant features of such a system: they also felt that to assume away the external environment and its influence upon such a system was not only a major weakness, but also unrealistic.

Studies such as those quoted above begin to throw light upon the problems of utilising Bucklin's theoretical framework as a basis for evaluating system performance and how changes may affect system performance.

One of the major difficulties is that while Bucklin's model can be reduced to a system of parametric equations, it would not be possible to attempt to quantify his hypotheses due to the difficulty of obtaining data, a problem he himself admits. The data requirements needed to evaluate the efficiency of a system are formidable. One would need data on commercial system costs of performing functions, data on the level of service outputs provided and most difficult, data on the various costs incurred by the consumer through participation in the system. For each of the service outputs, one would need to establish the relationships between costs and levels of service output for both the consumer and the commercial system, which presumably would need many observations of the same set of institutions performing different levels of service outputs. In order to then assess whether that set of institutions was efficient or not, presumably we would have to formalise the relationships for different sets of institutions to determine whether they can provide the same level of service outputs at lower cost or not. It is not even clear if one could adequately measure the costs of the different service outputs. For example, how would one establish the total channel cost curve (commercial and consumer) for different sets of institutions providing different degrees of market decentralisation. Even if this were possible, one also has the problem of how the other service outputs interact with each other and determine costs. The impossibility of quantifying the service outputs and the various cost relationships for different levels of service outputs is a problem Bucklin acknowledges; for this reason, his theory at best can only form a qualitative framework within which the problems of distribution channels can be studied.

Nevertheless, Bucklin still argues that the normative predictions his model makes about different levels of service outputs and the resulting distribution channel structure in meeting the minimum cost criterion are of use in the study of existing distribution systems. It is argued, that these normative predictions provide a "benchmark" against which the performance of actual systems may be charted in structural terms. One uses the principles and normative hypotheses to suggest what the normative distribution channel should be, and then presumably compare the theory with reality. Even if this constituted a fully satisfactory method of progress, it still depends on the quality of the theory. One has no method of validating the theoretical cost structures that Bucklin develops due to the various measurement problems. The result being is that one has no way of ascertaining the validity of the normative hypotheses developed. While this remains the case, any conclusions drawn from these normative predictions must remain in question.

Bucklin himself admits that the restrictive assumptions and the partial equilibrium approach that he was forced to adopt in order to enable the derivation of his theoretical model may make the relevance of his study to existing distribution systems of limited value. Bucklin's assumptions that all participants in the system are fully informed entities operating in a perfectly competitive environment striving in co-operation to minimise total channel costs in meeting some desired level of service output are surely too simplistic. For example, different market structures will surely affect how distribution systems operate. Is minimisation of total channel costs the only objective of the channel? The other aspects of performance such as profits, equity, channel stability do not enter the picture or are assumed away. Even if one accepts that minimisation of channel costs is an objective, how does one ascertain within the system what the minimum level of costs actually is? This assumed view of rational economic decision making, based on perfect information in a maximisation of economic efficiency framework has been attacked by several authors as too narrow and unrealistic, (for example, Gattorna J, 1978). This framework ignores many other internal strategic and external factors important in determining distribution channel structure and performance. For example, firms may have other objectives than cost minimisation such as maximising or aiming for satisfactory profits. Some firms may operate seemingly inefficient channels of distribution for other reasons such as improving market share or attempting to break into new markets. Behavioural factors, considered important by some authors (Stern L.W., 1969: Stern L.W. and Gill L.E., 1966) do not enter into the model. It is assumed within Bucklin's model that all institutions are in co-operation with each other at all times. Stern (1969) has shown that in many distribution channels, the exercise of power by some institutions and patterns of conflict and non-co-operation are important factors in shaping distribution channels. The external environment, in terms of cultural, political and legislative factors may well be a force in shaping distribution channel structures.

Bucklin acknowledges that there are a great many ways in which and reasons why one might expect the theory and reality to differ. Nevertheless, he still argues that knowledge of the normative, economically optimal system enables one to judge the efficiency of a system and also to identify barriers and reasons as to why a seemingly inefficient system exists in economic terms. As suggested above, there are many other considerations which might explain, quite rationally, why the actual system differs from the normative. The problem is that while questions remain with the validity of the hypotheses of Bucklin's model, one would not be sure if differences in reality from the normative were the result of this factor or the many other factors alluded to above.

Several further problems exist with the Bucklin model. In reality, for the purchase of many products, is it realistic to assume that consumers face a variety of distribution channels operating different levels of service outputs? In many cases, it is likely that consumers are faced with only one alternative. Another omission by Bucklin is that he does not consider the nature of the effects of different products upon the structure of distribution channels. In his work, there is an implicit assumption that the product is manufactured and storable, and that the level of desired service outputs determine the various functions performed in association with that product. However, many products, such as fresh fish, are highly perishable, and it is logical that this characteristic of a product will also have an important role in determining the structure of a distribution channel. Ignorance of this facet of a product might lead one to conclude that a structure was not normative when in fact it might well be.

The way in which Bucklin handles the effects of and response to various changes must also be questioned. Firstly, while Bucklin argues that this model can be used as the basis for evaluating the effects of various changes, he himself in his work does not really do so. Within the assumed framework, it would appear that the only forces of change would be changes in the demand for levels of service outputs. To Bucklin's model, this proves no problem as the functional and institutional structure changes instantaneously to meet this new demand for service outputs at a minimum cost. However, there are important influences upon the institutions within the system which will affect the system for which Bucklin's model has no answer. External changes in various costs will continuously change the cost structure of performing functions. The effects of changing economic conditions such as demand for the product itself are not openly considered, except in the context of changing demand for service outputs. Furthermore, Bucklin assumes that the input costs of the product itself, or production costs, remain constant; the only variable costs being variations in the cost of performing marketing functions in response to changing levels of service outputs..

Within Bucklin's model, institutions, their costs and profits are not affected by change. When changes in service output demand occur, the institutions adapt to a new normative equilibrium position. Even if one accepts this, it is a necessarily long term perspective. New institutional structures may take many years to emerge in response to new stimuli. This long term perspective within Bucklin's model ignores the possibility of the many short term effects for which distribution system structures cannot change, and will be affected in some way or another.

It has also seriously been questioned whether institutions in the long term do more towards the normative suggested by Bucklin and in response to change. McCammon (1964) was interested in why change appears to be resisted by marketing institutions even though such changes appear to offer economic advantages. For his explanation as to why uneconomic, non-normative channels persist, he turned to behavioural factors. McCammon identified reseller solidarity as a factor, whereby intermediaries act as a group, the result being a "don't rock the boat" situation. He further suggests that entrepreneurial values differ between large and small resellers, with large resellers being more growth orientated and responsive to innovation, whereas he suggests that small resellers have a different set of values characterised by relatively static expectations. He puts forward a third factor which he argues will act as a barrier to change, and that is organisational rigidity; the principle here is that well-established firms have deeply entrenched patterns of behaviour. McCammon argues that these patterns may lead to resistance to change, as it violates group norms and creates uncertainty. He further suggests that response to innovation will be incremental and imitative of other innovators.

A further facet identified by McCammon is that for most distribution systems there exists a dominant channel of distribution, which has the greatest prestige and often handles the bulk of an industry's output. Within this dominant channel, it is argued that there is an occupational code which controls pricing policies, sales promotion and other related activities. In relation to the dominant channel, and the occupational code, there are various groups. There are the "insiders" who are members of the dominant channel and are interested in perpetuating it. There are "strivers" who are located outside the dominant channel yet want to become a part of the system, and because of this, they do not engage in dominant behaviour as they utilise the same marketing practices as the insiders. One also has "complementors" who are outside the dominant channel yet perform complementary functions for the dominant channel; thus they wish to see it survive. McCammon suggests that the final group, the "transients" are the most likely to disrupt the occupational code as they are outside the dominant channel and do not seek to join it. But he also suggests that these "transients" are not sufficiently dependent upon the product line to develop an entirely new method of distribution. McCammon suggests that to explain major structural changes and their impacts within distribution channels, it is "outside" innovators who are completely responsible for major innovations.

McCammon's ideas are interesting in that they cast doubt upon Bucklin's concept of institutions adopting change in such a manner as to move towards the normative. Rather, McCammon's ideas suggest behavioural reasons why change is resisted and why inertia appears within distribution systems.

2.4 Summary

Having established that the areas of performance and prediction are important for study within the context of theoretical modelling frameworks, this chapter set out to review the major theories and concepts to determine whether any had been developed as a framework within which to study existing distribution system performance and form the basis of a model of the quantitative analysis of change.

It has to be said that much of the distribution channel theory comprises a set of descriptive truisms designed to explain in general terms why intermediaries arise in the process of exchange. Very few ideas have been developed to explain why particular distribution system structures emerge.

The one major theoretical work in the area (Bucklin, L.P., 1966, 1967a, 1967b, 1970) built on many of the earlier conceptual ideas in putting forward a general cost performance model of distribution channel operation. The expressed intentions of this work were for the theoretical model to provide a framework within which the problems of distribution channel performance and change could be studied and evaluated.

However, it was found that a number of problems exist with the model which cast serious doubt on its ability in these areas. Due to the complex nature of its construction, it cannot form a quantitative model due to measurement problems. The assumptions made and the partial equilibrium approach adopted also make the theory simplistic and unrealistic. The minimisation of total channel cost view is narrow and ignores many factors which contribute to distribution channel performance lessening its value as a "benchmark" against which existing systems can be evaluated. Changes in the context of the model are responded to by institutions which adapt to a new equilibrium position. The long run view ignores the many possible factors which may affect distribution channels in the short term, and also ignores the possibility that institutions cannot or do not adapt.

CHAPTER 3

THE DISTRIBUTION SYSTEM IN THE FISHING INDUSTRY

3.1 The Marketing of Fish

The fact that little was known about the area of fish distribution systems became evident in the late 1970's with a growing interest in the overall marketing of fish. In particular, this interest was confined to the fresh fish sector and the identification of problems therein. The "Marketing of Fish" report (M.A.F.F., 1981a) identified four key problem areas: the decline in fresh fish consumption which was largely attributed to rising prices and the poor image of fresh fish as a generic product as identified by MacSween (1973a, 1973b, 1973c); secondly, the shift in the pattern of fish consumption away from fresh to frozen fish; thirdly, the consequent decline in the retail distribution of fish and in particular the traditional fishmonger; and finally, the absence of successful product innovation in fresh fish.

In the light of these identified problems, the "Marketing of Fish" report (M.A.F.F., 1981a) and others (Ritson C., 1982) made various recommendations to improve the position of fish in the market place. Recommendations were made concerning product image, product quality, advertising and promotion and the creation of mobile retail outlets for fresh fish. Whilst suggestions were made as to the improvement of many areas of the marketing mix, little was said about the fish distribution system, apart from the problems endured by traditional fishmongers.

The principal reason for this was that very little was known about the fish distribution system in Great Britain, and in particular whether it was effective or not. The "Marketing of Fish" report (M.A.F.F., 1981a) stated :

"In the absence of any clear knowledge about the present distribution system for fish, the fish Promotion Executive should institute such an inquiry."

A second report by the Ministry of Agriculture, Fisheries and Food issued to meet EEC requirements (M.A.F.F., 1981b) suggested that the present distribution system for fresh fish was inefficient in some way or other, but was not able to be very precise:

"The price per pound the consumer pays for fish is on average about four times the price per pound the fishmermen received .... distribution costs are relatively high compared with those for meat or poultry."

This concern and emphasis upon possible problems within the distribution system for fresh fish arose principally due to the importance and distinctiveness of the distribution system within the overall fishing industry. It has already been suggested that marketing activities play an important role within an economy or industry, and that within marketing, the distribution system is of great importance. However, there are specific reasons for believing distribution to be of greater importance in the fishing industry, than for many other industries.

One of the most practical roles of a distribution system is the physical link it provides between points of production and points of consumption. Obviously, in this sense, the further away production is from consumption, the more important this aspect of the distribution system becomes. Within the fishing industry, the nature of the supply of the products means that production and consumption are subject to a high degree of spatial separation. For example, in 1982 landings of all fish species in Great Britain by United Kingdom vessels totalled £251,793,000. Of that total, almost exactly 60% was landed at the top ten ports in Great Britain of Fraserburgh, Ullapool, Aberdeen, Peterhead, Hull, Grimsby, Fleetwood, Lowestoft, Newlyn and Brixham. Not only are these ports all situated on the coast, but they also tend to be located in what might be termed peripheral regions within Great Britain, principally Scotland, the South West and Humberside. While the bulk of fish production is concentrated on the coast in outlying areas, the pattern of fish consumption in Great Britain is much more evenly dispersed throughout the country. The major physical task of the distribution system is to serve the major inland wholesale markets, some 4,000 indepedent fishmongers (5th Report of the Expenditure Committee, 1978), fish fryers, supermarkets, restaurants, freezer centres and other institutions located throughout the country who exist to serve the final consumer. (The fact that ports do not necessarily serve their local regions will be discussed at a later point.)

This spatial and also temporal separation of production and consumption, combined with the fact that fish is a highly perishable product, create a situation whereby speed and efficiency in distribution are of great importance, a factor one would expect to be reflected in high costs of transportation and communications.

In addition, the lack of standardisation of fish as a product and the consequent difficulties encountered in its classification would suggest a distributive system in which sorting activities play a large role, and also that a high level of understanding and confidence exists between buyers and sellers.

Given these various characteristics, one would expect to find that the distribution system for fish exhibited a high degree of integration. However, while in recent years the proportion of fish passing directly from port merchants to retailers, fish fryers and institutions has increased, the bulk of fish supplies still pass from the port merchants through the inland wholesale markets and then onto the various end users such as fishmongers and fish fryers (Rosson P.J., 1975). One of the chief reasons for this, as quoted by Taylor R.A. (1960), is that retailers and other users prefer to buy through this particular system because of the lack of standardisation and the difficulty of grading fish.

Two additional reasons would appear to also account for why the port merchant to inland wholesale market to retailer is still the predominant system within the fishing industry. Firstly, the fishing industry is typically comprised of a large number of very small businesses. For example, at Grimsby in 1980, it was estimated that there were approximately 200 independent port merchants (Sea Fish Industry Authority, 1981). It has already been mentioned that in 1978 there were approximately 4,000 independent fishmongers (5th Report of the Expenditure Committee, 1978). The upshot of this industrial structure is that horizontal and in particular vertical integration in the fishing industry is uncommon, with the result presumably that independent retailers prefer to be able to inspect and buy their supplies from the major inland wholesale markets rather than place orders for fish they have not inspected.

A second reason for the existence of this system is that unlike many industries, the fishing industry is subject to large and, for the most part, unpredictable fluctuations in supply, usually on a daily basis. This means that the distribution system must be organised in such a way to give flexibility in the landing and disposal of a variable supply. To some extent, the problem of heavy landings is met by fish passing through special channels for reduction to fish meal and pet food. However, the organisation of the system for fish passing into human consumption also needs to show flexibility. It has been widely held that the inland wholesale markets are the chief agents for clearing gluts. One would expect that the existence of central markets, to which retailers and fish fryers can come and where the numerous sellers receive fish from ports all over the country, would lessen the consequences of fluctuations in supply and help stabilise prices (Taylor R.A., 1960; Rosson P.J., 1975; Yap C.L., 1978).

The uncertainty element in daily supplies and to a lesser extent in demand, is also one of the chief explanations of the employment of the auction system of selling fish at first hand sales, so as to equate supply and demand in as short a time as possible for such a perishable product.

Given the importance of the distribution system within the fishing industry and its unique and distinguishing characteristics, it is somewhat surprising to find that the area has received little attention. In particular, few attempts have been made to evaluate the efficiency or otherwise of the system or the impacts of the many changes in recent years have had upon the system. However, it is to a review of those studies of fish distribution which have been carried out that we now turn.

CHAPTER 4

STUDIES OF FISH DISTRIBUTION SYSTEMS

4.1 Introduction

As was stated at the end of the last section, the objective of this section is to review critically the various studies that have been carried out relating to fish distribution systems. The following discussion falls into two sections: firstly, those studies which have been carried out in the United Kingdom, and secondly, those which have been carried out overseas and in particular in the United States.

4.2 United Kingdom Studies

Apart from there being very few studies of the fish distribution system in the United Kingdom, several of those that have been undertaken are content to describe the system through the use of summary statistics. Reports such as those carried out by Mintel (1981) and Keynote Business Information (1982) are content to describe the whole marketing and distribution system and comment upon the trends in consumption, production and prices. Little is said about the actual distribution system except that fresh fish normally passes from the port merchant to the inland wholesale market to the retailer.

Other studies, notably the investigation conducted by the Price Commission (1976) have considered the distribution system more explicitly. The concern here was to describe and explain the various cost components of fish throughout the distribution system from quayside to retailer. The study was conducted against the background of falling consumption of fresh fish, rising retail prices and decline in the number of fishmongers. As such, it sought to explain why on average the price per pound the consumer pays for fish is four times the price per pound the fisherman receives. To do this, the study then presents cost and profit information on the various institutions within the system to explain the price build up. The Commission was obviously concerned about the efficiency of the system as revealed in the following quote :

> "To the extent that distribution costs may be higher than they need be, prices in turn are higher and this contributes to the decline in the trade."

The above quote also reveals that the Commission had no available method for judging whether distribution costs were higher than they need be. In fact, the Commission recognised this in the following quote :

> "Whether there is room for improvement can only be answered in the light of detailed investigation into the organisation and efficiency of the trade."

Other official bodies concerned about the distribution system for fresh fish include the Sea Fish Industry Authority. In response to the various calls for an investigation into the distribution system, the Authority undertook research into the system and published its findings (S.F.I.A., 1983a). The aims of the investigation were principally concerned with the transportation system, and in particular the technical standards achieved by the system and the degree of deterioration of fish products while in transit. As such it was primarily a technical report, but it also set out to assess the capability of the system to respond to changes in the level of demand. However, the bulk of the study discusses various handling practices, noting problems where they exist. With regard to the system's capability to respond to changes in the level of demand, very little is said except that spare capacity exists on occasions. At best the report is a description and discussion of the transportation system and its various practices and malpractices. No analysis is undertaken, the conclusions reached appearing to be based on the researcher's opinions.

Perhaps the most comprehensive study of the fresh fish distribution system was undertaken by R.A. Taylor (1960). While dated, this study still remains the fullest and most informative. The purpose of his research was to describe the structure and organisation of the British fish trade, to analyse current trends in the industry and to suggest possible lines of development and their impact. In particular, he was attempting to put the widely held view of the time that the distributive system was wasteful and expensive into some form of perspective. Through a thorough description and discussion of production, consumption, port wholesaling, inland wholesaling, retailing, the costs of distribution, practices, problems and trends, he sought to explain why the system was structured as it was and why certain changes were taking place, such as the change to road transport from the railway system. Taylor's work stopped short of evaluating the efficiency of the system or evaluating the impacts of the changes he talked about. He did, however, indicate what he thought would be the pattern of future development of the system and the likely effects of that development. For example, he argued that problems associated with inland wholesale markets, and the growth of better communications would lead to the growth of the direct distribution system between port merchants and retailers to the detriment of the inland wholesale markets. Such a situation had indeed happened with major markets such as Billingsgate recording falling supplies of fish throughout recent years, and a parallel growth in the extent to which retailers buy directly from port wholesalers (S.F.I.A., 1980).

Taylor's interest in the problems faced by the inland wholesale markets in particular, was shared by R.J. Perkins (1969). Taylor considered one of the major deficiencies of his study to be the fact that his analysis of the inland wholesale markets was restricted through a lack of data to a consideration of the role of Billingsgate in the fish distribution chain. Perkins sought not only to update Taylor's material regarding Billingsgate, but also to include other inland markets. In particular, Perkins sought not only to provide more information regarding the physical operations performed by inland wholesale merchants, but also to indicate the effects on inland markets of developments elsewhere in the distribution system which had occurred since Taylor's time of writing.

Through the use of sample surveys and individual interviews, Perkins was able to show how the major inland wholesale markets act as points of assembly for fish and shellfish of high unit value and secondly how they act as an important link in the marketing chain for fish landed in Scotland and the smaller ports of England and Wales. Perkins was particularly interested in the effects of falling consumption and the declining number of traditional fishmongers upon the inland wholesale markets. As a result of these changes, Perkins shows that over the period 1956-1966, the volume of business at all the major markets had decreased by around 40%. Perkins does not explicitly examine the effects of this decline upon inland wholesalers, but rather explains the way that wholesalers have responded to this decline by increasing the proportion of their sales accounted for by fish of relatively high unit value, and also by reducing the variability of sales from day to day and from season to season so as to secure a more regular flow of business.

The only other major study of the fish distribution system in Britain was carried out by Rosson P.J. (1975). Rosson's chief interest was in the area of structural change and system performance. In particular, he was concerned that since the late 1960's, there had been many changes which had had a pronounced effect on the structure and functioning of the system, yet nobody had investigated them. He sought to explain the changes, such as falling consumption, the changing pattern of production, falling numbers of retailers, the growth of the frozen fish sector, and in particular to explain the reasons behind these changes. The basic conclusion was that there were problems with the product and its image, and also rising prices relative to other products.

Rosson's study of the fish distribution system is unique in Britain, as it is the only study which attempts to measure the efficiency of the system. Rosson uses the distribution cost method originally developed by Hollander (1961). However, his analysis is very unsatisfactory, as he himself notes, because of problems of data availability. Rosson is then reduced to summarising cost trends over the period 1925 to 1954, where he notes that the distribution cost element in the retail price of fresh fish had declined from 54% to 47%. Rosson concludes that as long as this trend has not been accompanied by a lower level of service, then it is to be welcomed. However, Rosson himself states that comparing distribution costs over time in this manner is an unsatisfactory measure of performance, primarily because given the many structural changes over the period, one cannot say if the level of service has improved or worsened as no data exists to enable such evaluation. Rosson also attempts to compare the gross margins of port wholesalers and inland wholesalers over the period 1938 to 1954. Whilst the data is very sketchy, it would appear that the margins of port wholesalers have increased whilst the opposite is true for inland wholesalers, which appears consistent with the fact that over the same period there was a growth in the direct distribution system, bypassing the inland wholesalers.

Rosson also considers the factors that are likely to have a bearing on the system and its operation in the future; factors such as the extension of fishing limits, future levels and patterns of consumption, fish prices relative to other products and the further growth of the frozen fish sector. Due to the fact that no model or method exists for answering these questions, Rosson is reduced to speculating upon the likely effects concluding that the future for the distribution system looks "turbulent".

4.3 Overseas Studies

Studies of fish distribution systems in countries other than the United Kingdom have taken various forms. The majority of the studies, however, tend to be descriptive concentrating on identifying the major aspects of the system in question and providing summary statistics (e.g. Cheng K.W.J., 1978; Chan K.W. and Lee N.K., 1978; McCoy E.W. and Hopkins M.L., 1980; Pili F. and Abella F., 1978; Guerrero C.V., 1978; Crawford K.W. et al, 1978).

While the above studies are descriptive, others have attempted not just to describe an existing system for the distribution of fish, but also to identify problems and propose recommendations on how to solve those problems. Thus J.P. Nicholls (1979) considered the principal problems of the seafood distribution system in the United States to be instability of prices and incomes, a lack of co-ordination and standardisation, and problems of access to markets. Nicholls suggests that the application of marketing orders regarding the regulation of quality, quantity and prices would aid in resolving the perceived problems.

C.L. Yap (1978) investigated the role of the wholesaler in the fish distribution system of Malaysia in response to the widely held view that in some way or another, the wholesaler was abusing the system. In particular, he investigated the functions of fish wholesalers and their profit levels, concluding that in fact the apparently high profits earned are in general due to the high levels of financial risk associated with such an activity.

P.J. Rosson (1974) takes yet another view in considering how the traditional fish marketing and distribution system fits into an overall Tanzanian fisheries development plan. In particular, he highlights the incompatibility between the political philosophy behind the plan and the realities of the traditional fish distribution system.

Studies of the above type, based on description and a general discussion of problems are relatively common within the overseas fish distribution literature. However, several authors have adopted analytical modelling approaches to the study of fish distribution system, particularly in the United States.

E.S. Penn (Penn E.S. and Crews W.J., 1979; Penn E.S., 1980a; Penn E.S., 1980b) attempts to develop a value added model of the entire United States fishing industry. In particular, he seeks to show the value of sales and the marketing margins at each stage of the distribution chain, notably the harvesting, processing, wholesale and retail levels. The ultimate aim of Penn's work, which bears close resemblance to methods of national accounting used in economics, appears to be to determine the contribution of the fishing industry and its component parts to the Gross National Product and also through the use of multiplier coefficients to estimate the additional income generated to the national economy. Penn argues that this approach is particularly useful for comparing the changing contributions of different industries to the national economy and also of use to management in drawing up policies for the fishing industry, although the exact way in which this approach would be useful is not made clear.

O'Rourke A.D. and Deloach D.B. (1970) were concerned about the efficiency of the Californian fresh and frozen fishery trade. They were interested in whether the industry structure and performance could be improved to fulfil better its economic and social functions. After a description of the structure of the industry and its problems, they attempted to analyse the economic performance of the industry.

The method they adopted in order to do this, raises major questions about the validity of their results. They used the assumptions of perfect competition to analyse the producer wholesaler sector. They then argue that the extent of deviations away from the perfectly competitive equilibrium position can be taken as an approximate measure of any inefficiencies present. For example, they use perfect competition to derive estimates of the optimal levels of labour and management for given levels of capital. Then by comparing these results with what they estimated in reality, they conclude that gross inefficiencies exist, especially in the use of labour relative to insufficient managerial talent. However, it is unlikely that this and other similar conclusions have much validity: firstly, because for their conclusions to be correct, the state of perfect competition would have to exist in both factor markets. No serious economist would ever advocate that perfect competition exists in reality, it is an idealised state used to demonstrate the functioning of a firm subject to severe restrictive assumptions. Because perfect competition does not exist, what they are in fact doing is probably charting some other market structure, not estimating its efficiency.

Schary P.B. et al (1972) attempts to construct a computer simulation model of a distribution channel for seafood marketing. The twin objectives are to describe the structure and functional organisation of the channel and to construct a computer simulation model to aid in understanding the forces which have shaped its development. The model is developed to show the allocation processes operating within the distribution channel for salmon; while the authors feel that it produces reasonable results, they are unable to test the validity of the model due to the fact that the detailed data required does not exist. Schary concludes that the model would prove useful in evaluating major changes in the system, and in particular the examination of changes in channel costs or demand schedules.

Prochaska F.J. (1978) has attempted to determine the functional relationship between the marketing margin and market prices, volume marketed, change in market structure and the cost of marketing services in the king mackerel marketing system in the United States. The reasoning for this approach was that in this particular marketing system, several co-operatives have been formed to raise fishermen's prices and reduce the excessive marketing margins enjoyed by wholesalers. Prochaska was particularly interested in identifying the effects of these structural changes in the marketing system.

His econometric model relating the marketing margins of wholesalers to prices, quantity, costs of marketing and dummy variables representing structural shifts in market structure was estimated with encouraging results. He was able to show how margins responded to price changes, also the effect of changes in quantity on the margins and prices received by fishermen, how the costs of marketing did not exhibit any statistically significant effect upon margins, and in particular how the change in market structure coinciding with the formation of the marketing co-operative led to significant increases in fishermen's prices and decreases in marketing margins to the benefit of the fishermen. This study by Prochaska represents one of the only attempts to evaluate the precise impacts of changes upon the performance of a distribution system.

The conclusion reached in United Kingdom studies, is that not only are there very few studies, but that the majority are concerned with describing the system, and sometimes outlining problems. Rosson P.J. (1975) is the only author who has attempted to evaluate the efficiency of the system; his attempts, while to be applauded, based upon comparing distribution costs over time are fraught with problems as he himself admits. With regard to the effects of various changes upon the system, most authors explain in general terms the effects with the benefit of hindsight. With regard to the many developments which occurred in the 1970's, such as limit extensions, entry into the EEC, falling consumption and so on, it is surprising that no author has considered or attempted to consider the effects upon the distribution system except in the most general terms. No doubt this is a reflection of two factors: firstly problems of data availability, and secondly, the fact that few methodologies exist in enabling these questions to be addressed; and those that have been developed (e.g. Bucklin L.P., 1966) would seem to be of limited application.

With regard to overseas studies, the story is much the same with the majority of studies being descriptive. However, several authors have gone beyond this; O'Rourke A.D. and Deloach D.B. (1970) attempt to estimate the efficiency of the Californian distribution system, although it has been suggested that their approach renders their results questionable. Schary P.B. (1972) attempts to construct a simulation model to evaluate the effects of changes in the system but cannot validate his results through data problems. The only study which has attempted to evaluate the impacts of change upon a system with any degree of success was undertaken by Prochaska F.J. (1978), who while interested in the past rather than the future, was able to use an econometric approach to successfully estimate the functional relationships existing within the distribution system for king mackerel.

CHAPTER 5

THE DISTRIBUTION SYSTEM FOR FRESH FISH IN THE SOUTH WEST

5.1 Introduction

Chapter 2 established that no adequate theoretical model or framework exists to enable the evaluation of the efficiency of a given distribution system or the effects of various changes upon such a system, especially in a predictive sense. Efforts that have been made to apply the models that have been developed to problems of distribution have been of limited value. While several of the existing studies of fish distribution have addressed problems relating to efficiency and change, the findings in general are inconclusive owing to methodological problems and a lack of data.

Before one can begin the process of constructing a model of the South West distribution system for fresh fish, one needs to achieve a detailed understanding of that system and an identification of the most important components of that system. This necessitates an evaluation of the current level of knowledge and understanding of the existing distribution system gained from published and unpublished sources in addition to the official data sources; secondly, an identification of gaps in the existing data; and finally, for those parts of the distribution system where knowledge is missing, the acquisition of the relevant data by the appropriate research methodology.

5.2 Existing Knowledge on the Distribution System for Fresh Fish in the South West

Three points need to be made at this stage. Firstly, to reiterate that this study is concerned with the distribution system for fresh fish in the South West of England, the system that operates for frozen fish including major processors is not considered here.

A second point is that although this study is concerned with the distribution system in Devon and Cornwall, one cannot conceive of a truly independent regional distribution system. Whilst landings and port wholesalers/merchants are located in different regions, once fish has been handled and packaged, and then despatched to the inland wholesale markets and many independent retailers such as fishmongers and fish fryers located throughout the country, that fish then becomes part of the national distribution system operating in Great Britain. Even retailers such as fishmongers and fish fryers located within Devon and Cornwall cannot be considered independent from the national system, in that while many of these institutions derive some proportion of their supplies from local port wholesalers, they also receive supplies, mainly cod and haddock fillets, from suppliers elsewhere in the country. The result of this is that when one is evaluating the current understanding of the South West distribution system, one is also referring to the national distribution system to which the South West is inextricably linked. Within this though, when one is evaluating existing knowledge about landings and port wholesalers, one is doing so with particular reference to the South West.

The final point to be made, is that in general the current level of knowledge and understanding of the distribution system for fresh fish is not very advanced. Very few official sources of statistics exist, those that do, referring to production and consumption only. To gain any understanding of the system by which fresh fish passes from production to consumption, the institutions involved, and the functions performed, one has to rely upon the few published and unpublished studies which have been undertaken. These studies almost exclusively refer to the national distribution system. Within this, the various institutions have received differing degrees of attention, retailers and inland wholesale markets the most. Port wholesalers have received attention, but only in those regions where the fishing industry has been most important historically, such as Scotland and Humberside. Virtually no information exists about port wholesalers in Devon and Cornwall.

Data on the consumption of fish and fish products comes from two sources. Firstly, the quarterly Household Fish Consumption in Great Britain, published by the Sea Fish Industry Authority (S.F.I.A., 1980-1983), which provides quarterly consumption and retail prices of major species in both fresh and frozen form for each television region in Great Britain. The major problem of this data series is that it has not been a continuous publication, therefore one cannot compare trends and patterns of consumption over any length of time. The other official data source on fish consumption is the Annual Report of the National Food Survey Committee (e.g. 1980), which provides annual consumption and expenditure per person per week for different forms of fish (e.g. fresh, chilled, fillet, whole, etc.), rather than for individual species. In addition, per capita fish consumption and expenditure is presented by standard region and by income group. The understanding of patterns of fish consumption is increased by published reports (Mintel, 1981; Keynote Business Information, 1982) which show the relationship between consumption of different forms of fish and factors such as household size and age of consumer. MacSween I. (1973a, 1973b, 1973c) has increased the understanding of the fish consumer through his studies of attitudes to fish and the frequency of serving fish. The above data sources refer principally to consumption of fish purchased from fishmongers, for cooking and consumption in the house. No official data series exists for consumption through other outlets. However, several published studies do allow some understanding: the Sea Fish Industry Authority (1983b) published the results of a survey of fish meals purchased at fish and chip shops. The study shows the number of meals served per week, the most popular species purchased, prices, the percentage consumed on and off the premises, social class and age, and the regional differences in consumption. Other components of fish consumption have also been studied. Moore A. and Palfreman D.A. (1971) consider the scale, nature and problems of fish consumption in schools.

While data is readily available for the many different aspects of fish consumption, the only other area where this is the case, is for the production of fish or more accurately landings. While much of the annual edition of the Sea Fisheries Statistical Tables (M.A.F.F. 1938-1982) relates to the size and structure of the fishing fleet and the amount of fishing effort applied to different fishing grounds, data is provided on landings. In particular, total landings of all demersal, pelagic and shellfish species for the United Kingdom are given annually. In addition, landings and values for all individual species are given annually for the major ports in the United Kingdom. Within the tables, data is included for four South West ports: Plymouth, Newlyn, Brixham and Falmouth. A further aspect of the Sea Fisheries Statistical Tables is that they provide data on imports and exports of fish and fish products, although one major problem here is the data does not refer to individual species, but rather to categories of fish products, such as fresh, frozen, preserved, canned or bottled, and therefore does not allow direct comparison with other statistics which present data on the quantities and values of individual species. A more recent publication by the Sea Fish Industry Authority (1984) attempts to get around this problem by presenting quarterly figures by species and category for imports and exports, the countries of origin for imports and destination for exports are also included. The major problems with this source of data are that to-date, only one edition has appeared, and secondly, the figures for exports are aggregated and not broken down by region or port.

While problems exist with data sources on production and consumption, notably problems of comparability between figures for the trade in fish products and landings, and also between landings and consumption, the data that is available is adequate for an understanding of production, imports, exports and the various facets of consumption. The data is aggregated, usually referring to the United Kingdom as a whole. The only data existing for the South West is statistics for the landings and values of individual species at the main ports on an annual basis. No data is presented for the other ports in the South West, hence one cannot determine the overall quantity and value of landings in the region or determine how important the main ports are relative to the rest of the region. The figures that do exist are annual figures which do not show the variations in landings and values which are considered such an important feature of the distribution system for fresh fish.

To gain any form of understanding of the commercial institutions, such as fishmongers, inland wholesale markets and port wholesalers/merchants, which comprise the distribution system for fresh fish is a much more difficult task, however. Unlike production and consumption, no official data sources exist which provide statistics on these various institutions. To derive any understanding of the particular sequences of institutions involved in the distribution of fish, quantities handled, species handled, prices, costs and marketing margins, one has to rely upon the few published and unpublished studies present in the literature. In general, these studies concentrate upon a description of the distribution system and a consideration of the features of the various institutions which make up that system. While taken together, these various studies present some understanding of the general characteristics of the distribution system, several problems exist. Firstly, the most comprehensive studies are fairly dated, making much of what they say of limited relevance; secondly, different time periods and methods of data collection make comparisons between studies difficult; and finally, while the studies tend to concentrate upon retailers and inland wholesale markets to which the South West is linked, apart from one unpublished study, no information on the port wholesalers/merchants in the South West exists. This is a fundamental obstacle to a qualitative understanding of the distribution system in the South West, because the port wholesaler/merchant is the critical link in the distribution chain, being the principal decision-maker in the system, deciding which distribution channels are utilised. Unless one has some understanding of the port wholesalers, one is not able to say through which distribution channels fish landed in the South West passes.

Most studies of fish distribution systems (e.g. Taylor R.A., 1960; Rosson P.J., 1975: Price Commission, 1976) generally agree that when fresh fish has been landed, it passes through one or two distribution channels; either through the auction system to port merchants to inland wholesale markets and finally to retailers, or through the same system but bypassing the inland wholesale markets. Some fish is exported, and some bought directly from the auction by local fishmongers and fish fryers.

Within this system, the characteristics of retailers have been considered. Species handled, quantities handled, prices, sources of supply, costs and gross margins have been documented in several studies (e.g. Taylor R.A., 1960; S.F.I.A., February 1980; Price Commission, 1976; Cartwright I., 1982).

Similarly, with regard to inland wholesale markets; the size of businesses, species handled, quantities purchased, sources of supply, prices, costs and gross margins have all been documented (e.g. Taylor R.A., 1960; Price Commission, 1976; Perkins R.J., 1969; Robins M., 1982a). In addition, Perkins R.J. (1969) considered the major buyers at inland wholesale markets, finding that retailers and fish fryers dominate fish buying.

Statistical information on port wholesalers in general is lacking. Taylor R.A. (1960) considers the functions performed by them, their gross margins and the different outlets they sell to. However, his sample is taken from port merchants located on Humberside. Similarly, the Price Commission (1976) data on costs and gross margins is taken from a sample located on the East Coast. A study of the fishing industry undertaken for EEC purposes (Commission of the European Communities, 1982) provides information on markets served by port merchants although the sample is taken from Scottish port merchants. The only information which relates to the South West is an unpublished report by the Sea Fish Industry Authority (Robins M., 1982b) which discusses the transportation of fish from South West England. While the study presents information on the relative importance of different routes operated throughout the country and the importance of inland wholesale markets, one cannot attribute too much importance to it. It is a study of the major independent haulier of fresh fish, it is not known to what extent the port merchants in the South West use the services offered by the haulier. Even if this transport study is representative of the port merchants, it only provides brief information on distribution throughout the rest of the country, it says nothing about the port merchants themselves and any other distribution channels they may operate.

The conclusion regarding the current level of knowledge and understanding of the distribution system for fresh fish originating in South West England is that very little information exists at all. Whilst some information exists on landings on an annual basis at major South West ports, nothing is known about what happens once that fish is landed. In particular, nothing is known about the functions of port merchants in the South West, the distribution channels they select for their products, the species handled, their costs and gross margins. Without information on these subjects, one cannot say how important inland wholesale markets are; the point is that until one has knowledge about the port merchants, the existing information on consumption, retailers and inland wholesale markets has little meaning as one does not know the relationships between these factors and the South West. Until one has that knowledge, one cannot achieve a detailed understanding of the distribution system.

5.3 Research Method

Having identified the major gaps in the knowledge of the South West Distribution system as being an almost total lack of information about port merchants in the region and to some extent a lack of detailed statistics on landings in the region, the next issue was to decide exactly what the data needs were, was that data obtainable, and the appropriate research method to be used.

The question of obtaining more detailed data on landings, to supplement the data available from the Sea Fisheries Statistical Tables, was resolved through the consultation of M.A.F.F. records at the local offices of Plymouth and Newlyn. The data collected here was for landings and values at the minor ports in the region, and also landings and values on a monthly basis for the major ports of Plymouth, Newlyn, Brixham and Falmouth. The collection of this data for the period 1972-1982 enabled the examination of total landings and values for the whole region. In addition, collection of the monthly figures demonstrated the variations in landings and values which occur throughout the year.

In order to achieve an understanding of the port merchants in the region, data on several aspects of their businesses was required. In particular, data on species handled, the functions performed, prices, distribution channels served, transportation, costs and marketing margins. While detailed factual information on these features was deemed desirable, preliminary investigations with M.A.F.F. personnel, who also provided background information regarding the distribution system, and with members of the local fishing industry revealed several potential problems. Firstly, port merchants do not keep particularly accurate or up-to-date records; secondly, they also keep records of their sales and purchases in value terms rather than quantity terms meaning that information on quantities of fish handled would be difficult to obtain, and would have to be collected in value terms; thirdly, it also became clear that data on the service outputs specified by Bucklin L.P. (1966) either did not exist or were unobtainable. A final factor relates to the groups of species for which data could be collected. While there are three distinct groups of fish, demersal, pelagic and shellfish, it became clear that in effect there are two distinct distribution systems operating in the South West; firstly, a system relating to landings of demersal and shellfish species made by indigenous fishermen, handled by local port merchants and distributed by them; and secondly, a different system for pelagic species, mainly mackerel. This is due to the fact that the vast majority of pelagic species are caught and landed by itinerant Scottish fishermen. As such these species are landed and distributed for a few months of the year in and around Devon and Cornwall (mainly at Falmouth), but are rarely handled by the indigenous fishing industry. It became clear that the collection of accurate data for pelagic species would be particularly difficult for the principal reason that they do not enter the region as such. It was, therefore, decided that this study would be concerned with the indigenous distribution system which operates for demersal and shellfish species.

A final problem revealed by preliminary investigations was that some of the data was of a sensitive nature and was unlikely to be released by port merchants, in particular here, data on selling prices, costs and profits. In effect, data on selling prices at one point in time would be relatively meaningless as one would expect prices to vary throughout the year, an estimate of the average selling prices can be gained from the size of the overall gross margin. However, there was no alternative to collecting data on costs, profits and margins, one had to accept that the likely rate of non-response would be quite high.

The problems noted above relating to the nature of the records held by port merchants did not necessarily mean that the necessary data was unavailable; rather it conditioned the nature of the data in that detailed figures on sources of purchases, particular functions performed and distribution channels used in quantity terms would be difficult to obtain and would have to be gained in value terms.

Having considered these potential problems regarding the form of the available data, the next issue was to decide the appropriate research method to be used. It was decided that a personal interview approach would be most likely to achieve the best results for several reasons. Firstly, a personal interview would realise a higher rate of response than a mail or telephone survey; secondly, and related to the first reason, was that owing to the sensitive nature of some of the data it was more likely to be revealed at an interview rather than by a mail survey; thirdly, with an interview approach, one could ensure that the person being interviewed was in a position to be able to provide the required data, and also in a position to decide whether to release the data. With a mail survey, the person completing it might not have been in the position to release the required information. A further reason for adopting the personal interview approach was that it would enable the clarification of any misunderstandings relating to the nature of the required information. The final reason why a personal interview approach was chosen was because it was important to have a partially unstructured approach which would allow one to probe on particular questions to elicit the necessary information. A mail survey with a structured questionnaire does not allow such flexibility.

Having decided the data needs, considered any problems and chosen the personal interview approach as the appropriate research methodology, the format of the interview was designed. Once this had been done, a pilot interview was undertaken with a port merchant in Plymouth in order to test its ability to provide the required information. The pilot interview was successful in all respects but one. It was found that the port merchant appeared unable to provide information on the values of individual species handled. The reason for this was that the business records did not contain figures for individual species, rather sales and purchase figures were kept in total. While this information did exist, the port merchant indicated that it would take too much time to work out the values of individual species handled. In the light of this problem, the interview format was redesigned not to ask for values of individual species purchased and sold, but to ask for the most important demersal and shellfish species handled in value terms. In all other respects though, the port merchant was able and willing to respond to the questions asked. A copy of the interview structure can be found in Appendix I.

Having designed and modified the interview in such a way that it provided the necessary information and enabled port merchants to respond, the final factor to be determined was the sample. Port merchants in the South West are concentrated at the three principal fishing ports of Plymouth, Newlyn and Brixham. At these three ports, there are thirty-six port merchants (M.A.F.F. estimate), all of whom were potentially available for interview. However, a random sample was not chosen for two reasons. Firstly, it was considered that personal introductions were important to achieve a satisfactory rate of response; secondly, it was hypothesised that decision rules among port merchants would differ according to size. On this basis, M.A.F.F. personnel in some cases facilitated a personal introduction and in others recommended likely co-operative respondents.

Of the thirty-six port merchants located at the three main ports, sixteen were contacted to provide an illustrative stratified sample. Of these sixteen port merchants, five refused to co-operate and incomplete interviews were conducted with another two. Nine port merchants completed the interview, providing the required information on market data. These nine included small, medium and large port merchants and seem to be a reasonable measure of total population behaviour. With regard to a detailed breakdown of operating costs, however, the anticipated higher rate of non-response occurred with four out of the nine providing the required data. The small sample of four, however, included at least one small, medium and large port merchant, and the gross margin of the four was sufficiently close to the gross margin of the total sample.

The results of the interviews are presented below. The data is presented in aggregate and relates to 1982.

5.4 Interview Results

The results are presented in two parts; firstly, the results of the first part of the interview dealing with purchases, distribution channels used, and functions performed; and secondly, the data regarding operating costs and gross margins is presented.

This first section is based upon the completed interviews of nine port merchants, whose total supplies amounted to £4,630,000 in 1982, 24.8% of the total value of all demersal and shellfish species landed in Devon and Cornwall. The range of individual merchants in the sample was broad, with one firm having annual purchases valued at £100,000, while another had purchases of £1,500,000. In general, the profiles of the merchants were strikingly similar with eight of the nine handling most demersal species with some shell fish. One merchant specialised in shellfish, while none of the sample handled pelagic species other than very occasionally.

Table 1 reveals the sources of supply of the merchants in the sample.

	Value	**% Total Purchases**
	£	
Auction	3,175,100	68.6%
Direct from Boats	1,029,000	22.2%
Other Wholesalers	425,900	9.2%
Total	4,630,000	100.0%

Table 1 Port Merchant Sources of Supply

The table reveals the dominance of the auction as the main source of supply for port merchants, accounting for over two-thirds of the total. The second most important source of supply is the boats themselves, whereby fishermen land directly to a particular port merchant bypassing the auction. The other source of supply quoted by merchants was other wholesalers, used principally when normal sources do not satisfy particular demands. This final source of supply relates not only to other wholesalers located in Devon and Cornwall but also to wholesalers located throughout the rest of the country.

Table 2 demonstrates the type of supplies purchased by port merchants.

	Value £	**% Total Purchases**
Demersal fish	3,589,000	77.5%
Shellfish	1,040,200	22.4%
Vegetables	800	0.1%
Total	4,630,000	100.0%

<u>Table 2</u> **<u>Port Merchant Type of Supply</u>**

As was mentioned earlier, data on individual species was difficult to obtain, therefore the aggregate types of species are presented above. One here can see that demersal fish species account for the bulk of purchases. All merchants handling demersal fish stated that they handled all the individual species landed in Devon and Cornwall at some time of the year. Very little specialisation with regard to particular species was noted, although some merchants did express particular preferences.

Table 3 below shows the form in which species were purchased.

	Value £	% Total Purchases
Fresh	4,561,000	98.5%
Frozen	38,000	0.8%
Smoked	31,000	0.7%
Total	4,630,000	100.0%

Table 3 Port Merchant Form of Supply

Here one can see the almost total dominance of fresh purchases of both demersal and shellfish species. The small amounts of frozen and smoked fish come principally from wholesalers located outside Devon and Cornwall.

Turning now to the data concerning the sales of port merchants, these totalled £6,125,000 in 1982, a gross margin for the whole sample of approximately 24%.

Table 4 below demonstrates the percentage of sales by form.

	Value of Sales	% Total Sales
Fresh	5,353,600	87.4%
Frozen or processed	771,400	12.6%
Total	6,125,000	100.0%

Table 4 Port Merchant Form of Sales

Here one can see that sales of fresh products form the bulk with 87.4%, the remainder being made up of frozen or processed products. A comparison of Tables 3 and 4 gives an indication of the degree of filleting, smoking and freezing undertaken by port merchants. While the bulk of sales are of the fresh head on form, processed product sales form 12.6% of the total.

Purchases of processed products totalled 1.5%, the difference between the two figures being some indication of the degree of processing of various kinds undertaken by port merchants. However, the bulk of merchanting functions are concerned with the sorting, grading and packing of fresh whole fish.

Turning now to the distribution channels used by port merchants, there are three main channels served as shown in Table 5.

	Value £	**% Total Sales**
In Region	734,900	12%
Ex Region	2,451,900	40%
Export	2,938,200	48%
Total	6,125,000	100%

Table 5 Port Merchant Distribution Channels

The least important channel in total is the In-Region channel, which refers to sales within Devon and Cornwall. The 12% of sales within the region is allocated in the following way :

	Value £	**% Total In-Region Sales**
Fishmongers	336,250	45.8%
Hotels and Restaurants	215,000	29.3%
Other Wholesalers	77,400	10.5%
Customers	59,000	8.0%
Processors	33,250	4.8%
Fish Fryers	12,000	1.6%
Total	734,900	100.0%

Table 6 Port Merchant In-Region Distribution Channel

The Table shows the importance of fishmongers in particular, but also hotels and restaurants. Together, these two types of outlet account for three-quarters of In-Region sales. In total here, 15.3% is distributed indirectly, while 84.7% is distributed directly to the final outlets or the customers.

The second most important distribution channel is for sales outside the region throughout the rest of the country. Some 40% of total sales passed through this system and were broken down in the following way :

	Value £	**% Total Ex-Region Sales**
Inland wholesale markets	1,532,700	62.5%
Other Wholesalers	392,800	16.0%
Processors	407,400	16.6%
Fishmongers	120,000	4.9%
Total	2,451,900	100.0%

Table 7 Port Merchant Ex-Region Distribution Channel

Of sales leaving the region, only 4.9% is directly distributed to the final institutions, the majority passing on to other wholesalers, processors and the inland wholesale markets before passing to retail institutions and finally into consumption. The inland wholesale markets receive the most important share of the total with 62.5% of sales. The particular inland markets served are shown in Table 8.

	Value £	% Total Ex-Region Sales
Billingsgate	1,019,100	41.7%
Birmingham	300,000	12.2%
Liverpool	175,000	7.1%
Bristol	37,600	1.5%
Total Inland Wholesale Markets	1,531,700	62.5%

Table 8 Port Merchant Sales to Inland Wholesale Markets

The validity of these figures, and the domination of Billingsgate, is confirmed when one compares them with the previously mentioned survey of the transport haulier undertaken by the Sea Fish Industry Authority (Robins M., 1982b). The results are comparable because all merchants in the sample who had sales outside the region relied exclusively upon this transport haulier for the transportation of their fish. The survey by S.F.I.A. found that of all fish carried by the haulier, 61% passed to inland wholesale markets, of which Billingsgate accounted for 32.3%, Birmingham 12.0%, Liverpool 10.2% and Bristol 6.6%. Whilst not exactly identical, these results confirm the relative importance of the various inland markets found in the sample data.

Apart from the problems noted earlier, an additional problem was discovered relating to the distribution channel for exports. While the survey revealed this to be the most important channel for fish in the sample, accounting for 48% of sales, it was not possible to break this figure down in the same manner as for the other two distribution channels. The primary reason for this was a reluctance on the part of most merchants in the sample to reveal the exact destination and institutions which received sales abroad. Nevertheless, several features became evident: firstly, most fish passes indirectly in that it passed to inland wholesale markets or other wholesalers rather than directly to retail institutions; and secondly, the major countries to which exported fish passes are France and Spain.

The second part of the interview related to the overall gross margins of port merchants in the sample, and the various operating costs incurred by them. The gross margin for the whole sample was 24%. If one excludes the one merchant who specialised in shellfish who had a gross margin of 32%, reflecting higher costs associated with the processing of shellfish, the gross margin of the sample primarily for demersal fish becomes 20.48%.

Of the nine merchants who completed the first part of the interview, only four were willing to give detailed cost breakdowns of their businesses. The gross margin of these four merchants was slightly lower at 19.19% but sufficiently close to the overall margin for the sample referring to demersal fish of 20.48%. In addition to this, the four merchants were representative of the overall sample. The detailed cost breakdown of the four merchants is presented below in absolute terms to avoid identification of individual merchants.

	Value (£)	%
Cost of Fish	2,720,000	80.81
Gross Margin	646,000	19.19
Costs:		
Packaging	81,450	2.42
Communication	18,500	0.55
Documents	11,450	0.34
Ice	20,530	0.61
Salaries	136,000	4.04
Labour	68,000	2.02
Own Transport	24,570	0.73
Hire Transport	37,360	1.11
Other[1]	85,160	2.53
Total Costs	483,020	14.35
Net Profit	162,980	4.84
Total Sales	3,366,000	100.00

Table 9 Financial Results of Wholesale Port Merchants 1982

The figures presented above compare favourably with the last survey of costs and margins undertaken by the Price Commission (1976). In that survey of East Coast port merchants, a gross

---

1. Other costs include depreciation, interest charges, cold storage charges, repairs and renewals, electricity, rent, rates and insurance.

margin of 15.75% was reported for 1975. Of that net profit was 4.39%, and total costs 11.36%. While the overall figures are reasonably similar, the main difference would appear to be with regard to total costs which appear higher in 1982 for the South West than was the case in 1975 for East Coast port merchants. While the individual cost components such as labour and packing are very similar for both samples, the major differences relate to addtional costs incurred by South West port merchants. Port merchants in the Price Commission survey undertook very little exporting. It was shown earlier that in this sample, 48% of sales were exported. Associated with exports are the costs of obtaining export certificates and of communications such as telex. For some reason or other, transport costs do not appear in the Price Commission findings. The sample data for the South West shows that transport costs form a considerable proportion of costs. In particular here, are the transport costs of hiring the major haulier in the South West, which all merchants in the sample used, for the distribution of fish to other parts of the country.

The other costs, namely labour and salaries, and packing materials together form the major component of costs in very much the same way as the Price Commission found. The high costs of labour and packaging reflect the fact that fresh fish port wholesaling is a labour intensive activity, one of the primary functions of which is the sorting, cleaning, grading, boxing, icing and packaging of fresh fish for distribution, most of which is still done by hand, hence the high labour costs.

The data presented in the above tables resulting from the personal interviews of port merchants at Plymouth, Newlyn and Brixham, whilst suffering from some problems resulting from unobtainable data and a small sample particularly in relation to operating costs, does, however when combined with knowledge of landings and the higher levels of the distribution system such as inland wholesale markets, retailers and consumers, allow an understanding of the South West distribution system for fresh demersal fish and shellfish to be achieved. An overview of that system is now presented.

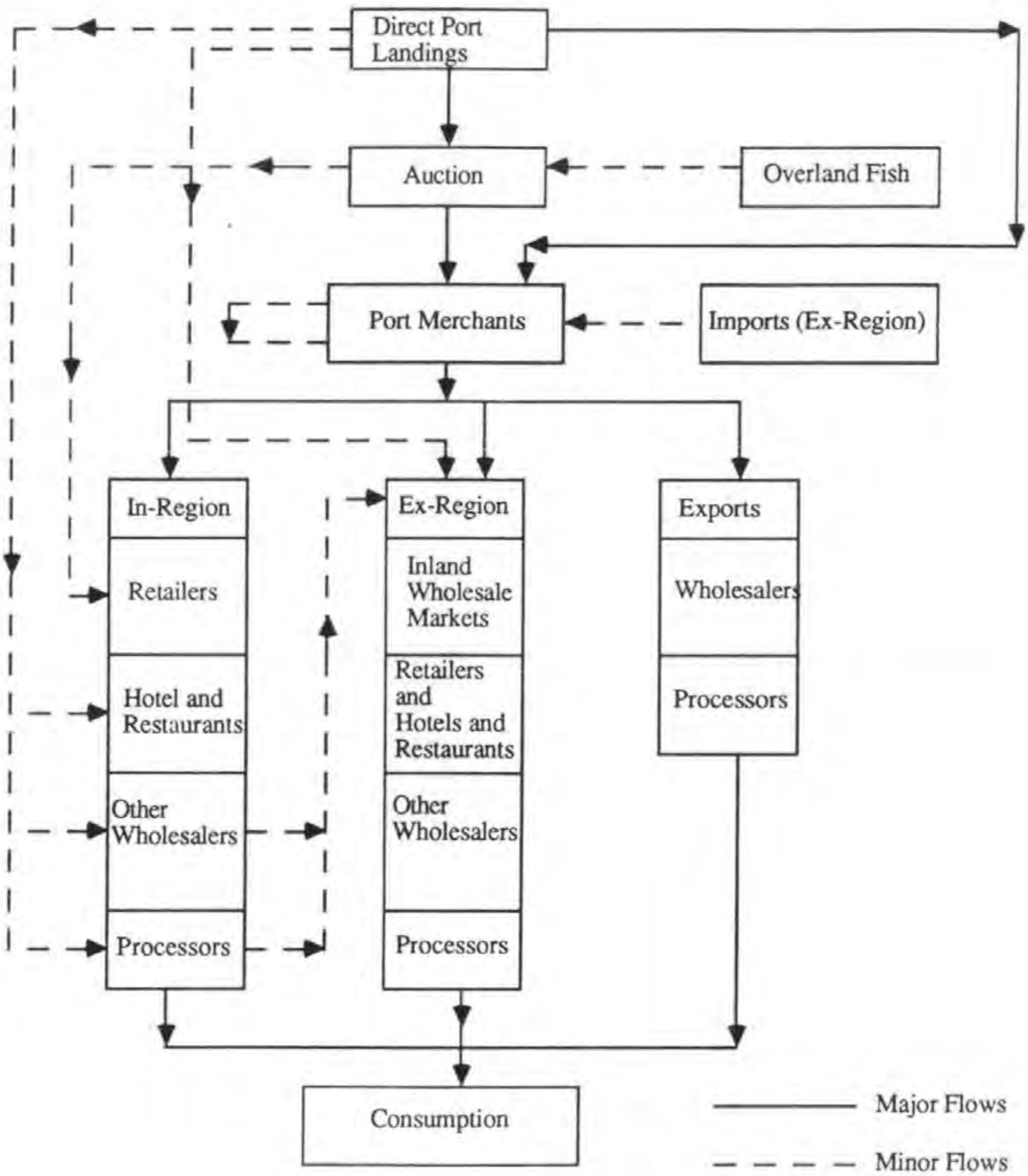
5.5 <u>The Distribution System for Fresh Demersal Fish and Shellfish in the South West</u>

From the data on landings obtained from the Sea Fisheries Statistical Tables and the M.A.F.F. local offices, background information provided by M.A.F.F. personnel, and most importantly the survey of port merchants at the three major ports, it is possible to identify the key features of the distribution system for fresh fish in the South West, and also to construct the descriptive model of the system as shown in Figure I overleaf.

Obviously, such a diagrammatic representation is a considerable simplification of the complexities of the real world system. In addition, there are undoubtedly flows within the system for which knowledge still does not exist. However, Figure I does show the principal features, institutions and flows of fish within the system. The importance of the various flows within the system varies considerably. The less important flows are depicted by the dotted lines, the most important by the unbroken lines. For example, at small ports situated throughout Devon and Cornwall, where no auctions or port merchants are located, fish is sometimes sold directly to processors, hotels and restaurants, or distributed to the rest of the country. The most important flows concern landings at the three main ports of Plymouth, Newlyn and Brixham, which pass either through the auction, or directly to the port merchants, who then perform various functions before distributing fish within the region to the rest of the country or exporting it. The concern here is to give an overview of the most important features and flows within the system.

Figure 1

Overview of the Marketing and Distribution System for Fresh Demersal Fish and Shellfish in the South West



5.5.1 Direct Port Landings

Table 10 shows the landings and values of demersal fish and shellfish for the years 1972 and 1982 throughout Devon and Cornwall.

	1972		1982	
	tonnes	£	tonnes	£
Demersal	4,412	927,220	15,760	13,647,533
Shellfish	4,052	685,461	4,782	3,879,260
Total	8,464	1,612,681	20,542	17,526,793

Table 10 South West Demersal and Shellfish Landings
(Source : M.A.F.F.)

One can see the considerable growth in total landings over the period, mainly as a result of the growth in demeral landings. In fact in 1972, demersal landings by value accounted for 1.6% of the England and Wales total; by 1982, this proportion had risen to 17.1%. Landings of shellfish species in Devon and Cornwall have always been important in the national context, being some 23.3% of total shellfish landings in England and Wales in 1972. By 1982, this figure had risen to 26.0%.

In 1982, some 33 different demersal species were landed throughout Devon and Cornwall. However, the bulk of the total was made up of the ten species shown in Table 11. Virtually all of the growth in overall demersal landings over the ten year period up to 1982 was accounted for by growth in the landings of the individual species listed in the table. While species such as Dogfish and Ling are the most important in weight terms, in value terms, Monkfish and Sole are by far the most important.

	1982	
	tonnes	£
Dogfish	1,646	696,002
Monkfish	1,491	2,418,351
Ling	1,481	575,040
Megrim	1,309	1,024,895
Plaice	1,163	651,837
Sole	1,073	3,112,682
Whiting	1,066	311,788
Lemon Sole	824	979,454
Hake	817	1,146,821
Skate	723	373,830

Table 11 **Major Demersal Landings 1982** (Source : M.A.F.F.)

Seven species of shellfish are landed in Devon and Cornwall, the most important three being listed below in Table 12.

	1982	
	tonnes	£
Crabs	2,962	1,780,512
Scallops	1,141	879,015
Squid	502	463,145

Table 12 **Major Shellfish Landings 1982** (Source : M.A.F.F.)

The total landings of demersal fish and shellfish of 20,542 tonnes in 1982 were made at some twenty three ports in Devon and Cornwall. Many of these ports are small, having landings below an annual value of £100,000. The vast majority of landings are made at the three ports of Plymouth, Newlyn and Brixham. Together, in 1982, these three ports accounted for 83% of the region's demersal landings by value and 40% of shellfish landings. The reason for the lower percentage for shellfish is, that while scallops and squid are mostly landed at the three ports, the majority of crab landings are made at Dartmouth and Salcombe.

In general, when one is talking about demersal and shellfish landings in Devon and Cornwall, one is talking about landings at Plymouth, Newlyn and Brixham as they dominate the region. While this is the case, there are several differences between the ports. While all three handle some thirty three demersal species, they do so to differing degrees. Brixham concentrates upon the high unit value flat fish such as Dover Sole, Lemon Sole, Plaice, Monkfish, Turbot and Brill; Newlyn concentrates upon Dogfish, Ling, Megrim, Sole, Monkfish and Skate, while Plymouth concentrates upon Monkfish, Lemon Sole, Plaice and Hake. In addition, landings of individual species, and in total, fluctuate throughout the year, often in a different fashion at each of the three ports.

5.5.2 The Organisation of First Hand Sales

Fish is usually landed in a head-on whole form with the entrails removed. In addition, it is usually boxed, iced and sorted at sea into different species and into different grades of the same species.

It was mentioned earlier that some landings, particularly of crabs at smaller port, pass directly to processors or out of the region. Also, some landings, again of crabs at smaller ports, pass directly to port merchants located at the main ports. However, these flows are very small in relation to the major ones. Demersal and shellfish landings at Plymouth, Newlyn and Brixham pass through one of two systems shown in Figure I. Firstly, landings can pass directly to the major port merchants who in this case are acting as boat agents. The majority of landings, however, are sold at the three ports through the auction system. Fish is sold by port merchants at the auction principally to other port merchants. While numerous retailers, mainly fishmongers, purchase their daily supplies from the auction, it is estimated that they account for no more than 5% of the total offered for auction (Industry estimate), the remainder is purchased by port merchants. So with regard to the two main methods of first hand sale, port merchants dominate fish buying at the three ports. The relative importance of the two different systems is revealed in the sample data presented in the previous section, where port merchants received 68.8% of supplies from the auction and 22.2% directly from the fishermen.

As stated above, fish auctions are held on a daily basis at Plymouth, Newly and Brixham. At Brixham, the auction is controlled by one company, at Newlyn two companies, and at Plymouth three companies. Fish auctioned on a daily basis at the three ports not only comes from the port where the auction is held, but also from several smaller ports where auctions are not held. For example, Plymouth daily receives fish for auction from Looe; Newlyn receives fish from Mevagissey and Falmouth; while Brixham receives fish from Padstow and Dartmouth. This feature serves to increase the importance of Plymouth, Newlyn and Brixham as sources of fresh fish in the regional context.

Prices realised at auction are determined by the interplay of supply and demand. Due to the fact that supply and demand are equated and market clearing takes place (i.e. no fish is left unsold and goes through the withdrawal price system), the prices realised at auction are equilibrium prices. These prices vary throughout the year, between ports and between different species and different grades of the same species. The prices paid by port merchants either at auction or directly to the fishermen who supply directly are usually the same. The reason for this is that if a port merchant consistently paid the fisherman landing directly to him less than the comparable auction price, then the fishermen would land to the auction instead. The auction price is used as a guideline for prices paid by port merchants to the fishermen who land directly to the merchants. This form of loose contract sale system bypassing the auction offers advantages both to the merchants and to the fishermen. In times when supplies are short, the merchant is guaranteed supplies of fish, and when supplies are heavy, the fisherman is guaranteed a sale and a price higher than he could normally expect at auction. The system operates to reduce some of the uncertainties arising from the fluctuations in landings.

5.5.3 Distribution after First Sale

Fresh fish and shellfish landed directly to port merchants at the quayside is transported by the port merchants back to their premises. Similarly, once the auction of fish has finished, the merchants transport the fish in the same way as above. Once this has occurred, a variety of functions may take place. Most of these functions relate to the sorting, cleaning, further grading, icing and packaging of fish ready for distribution. Some degree of further processing takes place, as revealed in the last section. This relates mainly to the filleting and sometimes smoking of fish; very little freezing takes place. The processing of shellfish is concerned mainly with the removal of scallops from their shells, and the extraction of meat from the crab, although most crabs are distributed live if possible as they fetch a premium price. The survey of port merchants revealed the extent of further processing and purchases of processed products; however, the vast majority of sales are of the whole fresh form. Fresh fish purchased in the morning is usually distributed the same day, although with the export channel, it may require chilled storage overnight.

These functions are reflected in the costs associated with the port merchant. In particular, the activities of sorting, cleaning and grading are reflected in the costs of labour; these and other costs, notably ice, packing materials and transportation all contribute to a gross margin of 19% revealed in the last section for demersal fish. This gross margin can be regarded as the percentage increase in the purchase price of demersal fish necessary to cover costs, risk and provide an adequate return to the merchant. The margin revealed in the sample for 1982 would have added £1.03 per stone to the average 1982 demersal price at Plymouth, Newlyn and Brixham per stone of £5.50. The margin associated with merchanting shellfish is higher resulting from higher costs of processing and storage associated with, in particular, crabs. The merchant in the sample specialising in crabs revealed a gross margin of 32%.

Once the various functions have been performed by port merchants, demersal fish and shellfish are distributed into three broad channels, all shown on Figure I.

The first of these is the local region channel characterised by direct distribution mainly to fishmongers and hotels and restaurants. Generally here, merchants will undertake delivery of fish to buyers, but some fishmongers prefer to inspect fish before purchase, and thus collect it themselves. This channel is characterised by daily sales, with mongers purchasing small lot sizes enough to satisfy their daily demand. One interesting point here, is the absence of fish and chip shops as customers of port merchants. This is probably a reflection of two factors; firstly, that fish and chip shops sell mainly cod and haddock (Rosson P.J., 1975), while not much cod, and virtually no haddock is landed in Devon and Cornwall; a second factor is that fish and chip shops buy frozen fillets, while port merchants in Devon and Cornwall undertake little freezing and filleting.

The second distribution channel is dominated by the inland wholesale markets. While the sample revealed 40% of sales leaving the region, nearly two-thirds of this was made up of sales to other merchants located at the major inland markets. This channel is characterised by daily deliveries undertaken by an independent transport haulier whose services were utilised by all merchants in the sample. As one would expect, the assortment of species and the average lot size passing through this channel are typically greater than for the local direct distribution channel. In addition, some sales are made through this channel to wholesalers not located at inland markets, and processors.

The final and most important distribution channel utilised by port merchants in the sample is the export channel, accounting for some 48% of sales by value. While accurate data was not obtained, it is clear that this is an indirect distribution channel dominated by sales to wholesalers. Another factor relating to the export channel is that the range of species sold is limited to those with a high unit value. Typical species exported are Dover Sole, Lemon Sole, Monkfish, Hake, Turbot and Brill. Another feature of this channel revealed by the sample data is, that it would appear that the larger merchants are the only ones who participate in this channel.

While only a brief overview of the distribution system is given above, it does allow an identification of the most important institutions and flows within that system and also how the South West system relates to the higher levels of the national distribution system for which some information and understanding already exists.

One feature which does become clear is the crucial role played by the port merchant in the system. They are by far the most important buyers of fish in the system; they are the key decision-makers deciding what and how much to buy and where sales are made; they decide the form of the product and the price it is sold at; they are also the major risk bearers in the system.

Comparisons of the system identified in the South West with other studies of distribution systems in the United Kingdom are difficult as these other studies do not, with one exception, determine the relative importance of the different flows and institutions within the system. The majority of studies (e.g. Taylor R.A., 1960; Rosson P.J., 1975) include a diagrammatical representation of the system but are unable to say which flows are the most important except in the most general terms. The one exception is the study undertaken by the Price Commission (1976). Included in this study is an aggregated breakdown of port merchant sales for 1975. The sample is of Humberside merchants and reveals several differences to the results of this study. The Price Commission found that most sales were made to inland wholesale markets or direct to fishmongers and fish fryers. Also included were sales to institutions such as prisons and to pet food companies. Exports accounted for 2.6% of total sales. It was found in the South West that sales to fish fryers, institutions, and for pet food were non-existent. In addition, 48% of sales were exported compared to the very small percentage revealed in the Price Commission survey. The other comparison with the Price Commission study relates to the form of sales. It was found in the South West, that only some 12% of sales were of processed products, the vast majority being sold fresh and whole. The Price Commission study found that 70% of sales were of filleted fish, mainly cod and haddock.

Some of these differences can be explained by a more general consideration of the South West distribution system compared to that operating elsewhere in the United Kingdom.

Perhaps the most striking contrast is the absence of frozen fish in the South West. Fish is landed fresh and for the most part distributed fresh and in a whole form. Landings of frozen at sea fish form an important component of supplies at Scottish and East Coast ports (Rosson P.J., 1975). This means that those large processors and frozen food companies specialising in frozen products are included in the distribution system, whereas they are absent in the South West. Another general difference relates to the assortment of species landed. Most Scottish and East Coast ports concentrate upon landings of Cod, Haddock and to a lesser extent Plaice, whereas the South West lands an enormous variety of demersal species with no one species dominating landings. If anything, the South West concentrates upon landings of high unit value species which are more popular in different countries rather than the United Kingdom, where to the housewife, fish means Cod and Haddock (M.A.F.F., 1981a). This is perhaps an additional reason for the importance of exports in terms of value and cost in the South West.

In general, while the South West system has many similarities with the system elsewhere, principally the role of port merchants, inland wholesale markets and fishmongers, the concentration of the South West upon fresh whole landings of a variety of species leads to the several important differences, noted above.

5.6 Towards a Model of the Distribution System

The identification of the key features of the South West distribution system for fresh fish, as discussed in the previous section, marks the attainment of the first objective of this thesis. We have achieved a descriptive understanding of the system, including information on prices, landings, the importance of the major ports, the crucial role played by the port merchant in the system, the functions performed, the importance of different distribution channels, the institutions to which fresh fish passes before being purchased by the ultimate consumer and the various costs involved in the system. However, while the above is adequate for the construction of the diagrammatical model shown on page 84, it is still only a description of the system.

In short, to provide a deeper understanding of how the system performs, there is a need to develop an analytical model within which one can study fresh fish distribution system problems. In addition, if such a model is to be of use to those in managerial and administrative positions in the fishing industry, it needs to be able to analyse future problems as well as existing ones. This section will show how the work completed thus far will develop in later chapters into a modelling framework with the above capabilities.

At this stage, several important questions need to be addressed. Firstly, what is to be the main objective or objectives of the model to be developed; in other words, what distribution system problems will the model enhance the study of? Secondly, what features of the distribution system as identified should be included in the model? Finally, what method or methods should be adopted in the model's development once the first two questions have been resolved?

In discussing the first of these issues, one can refer back to earlier parts of this thesis. Chapter 2 established that two areas within the marketing and distribution literature are of particular importance; firstly, the study of how efficient a given distribution system is in meeting some criterion or other; and secondly, the evaluation of the effects of changes in economic conditions upon the performance of institutions within a distribution system. Chapter 2 also established that few adequate models or frameworks had been developed to assist in studying the above problems. Those models which have been developed, are of limited value when applied to existing distribution systems. Chapter 3 revealed that concern has been expressed about the lack of understanding of fresh fish distribution systems. This chapter also outlined the distinctive characteristics of the United Kingdom distribution system and established its uniqueness in that for the most part the system has little control over the supply of the raw material and is subject to fluctuations in quality and quantity. The view taken in this thesis follows that of Taylor (Taylor R.A., 1960) which suggests that this vulnerability to external changes is a determining characteristic of the structure and functioning of the system rather than a problem which should be solved in some way by the system, as has been suggested by some (M.A.F.F. 1981a). In essence, the system is subject to influences over which it has very limited control. Chapter 4 reviewed United Kingdom and overseas studies of fresh fish distribution systems and found that many studies (e.g. Rosson P.J., 1975) were concerned about possible inefficiencies in the system found in the United Kingdom and the impacts of external changes in recent years upon it. The majority of United Kingdom studies have failed to address such problems except in the most general terms. Studies of overseas fish distribution systems have attempted to develop more analytical modelling approaches towards such problems, but with limited amounts of success.

It is clear that if the development of a model of the distribution system based in Devon and Cornwall (with general applications) is to be of use then it must reflect these essential characteristics and problems of the system. It is argued here (and developed in later chapters) that the model should have the ability to explain and forecast the effects of various external changes upon the system and its performance.

Of central concern to the fishing industry in the South West at the present time, is the anxiety expressed at the effects of large changes, not only in the total supply of fish, but also in the supply of important individual species such as Dover Sole, Hake and Monkfish. These changes in supply are not only the result of natural fluctuations in landings which are in themselves important, but also the result of enforced management measures deemed necessary to conserve individual fish stocks (such as recent bans on Dover Sole fishing in the South West). These types of measures are likely to become even more important in the future, with annual quotas being set for an increasing number of important species. In addition to developments on the supply side of the system are other measures designed to increase the consumption of fresh fish in the United Kingdom. The most important is the marketing campaign being pursued by the Sea Fish Industry Authority which is designed to increase the consumption of fresh fish and hence the revenue to the fishing industry. If consumption were to increase, then it is likely that there would be a feed back effect on prices and revenues of the different institutions within the system. With regard to the effects of these and other changes upon the system, little has been said and little is known. The development of a model with the ability to explain and forecast the quantitative impacts of these major changes upon the system will be of considerable importance.

One possibility would be to use the theoretical framework developed by L.P. Bucklin (1966) as the basis of a model of the distribution system. While Bucklin's model was constructed with the specific intention of allowing a researcher to examine the real world effects of changes such as demand and supply upon the structure and functioning of a given distribution system, sufficient problems exist which would make the application of Bucklin's framework to the distribution system in the South West extremely difficult. Chapter 2 discussed the severe conceptual problems that exist with Bucklin's model. In addition, it was found that data on the specific service outputs specified by Bucklin either did not exist or were not measurable, a problem he himself recognised. The only way in which one could use this model, would be to take the normative hypotheses that Bucklin develops about the relationships between different levels of service outputs and the structure and functioning of a distribution system. Presumably, one could change the levels of service output of a system and predict what would happen in reality to the structure of the distribution system based on the normative hypotheses that Bucklin puts forward. The problem is, however, that these normative hypothesised relationships have never been empirically validated, primarily because one cannot measure the specific service outputs. The result of using Bucklin's framework in the above way would be to arrive at a number of imprecise qualitative predictions about the way the distribution system would respond to changes in the level of service outputs. These predictions would be extremely difficult to validate, and given the idealised world in which they were constructed, it is unlikely that conclusions reached on their basis would have much relevance to the real world.

Having rejected Bucklin's framework as a suitable basis for a model of the South West distribution system above and in earlier chapters, a new approach had to be adopted in the light of the identified objective. In particular, it has to be determined which aspects of the system will form the basis of the model and what methods will be used.

The system as identified is extremely complex and is comprised of many components and interrelationships. This is especially true when one remembers that landings of a wide variety of species are made at the three ports of Plymouth, Newlyn and Brixham. Once landed, fish can pass either through the auction or directly to the port merchants (although analytically the prices paid in both of these flows are likely to be the same, as discussed in the previous section). After various functions have been performed at some cost by the port merchants, fish can pass into any one of the distribution channels in Figure 1 on page 84 before passing into consumption; whether this is domestic or foreign.

Owing to the complexities of the system, it was decided that the model's development should focus upon the most important institutional level in the system and the one most likely to bear the brunt of external changes particularly on the supply side, the port merchants. To illustrate this point, inland merchants can switch suppliers in times of shortage to those where supply is more plentiful. Port merchants do not have this flexibility, being located at ports and remaining largely dependent upon landings made at their port of location. The modelling approach adopted though, has a general application to the other institutions within the distribution system, such as inland wholesale markets and retailers such as fishmongers who specialise in sales of fresh fish. The approach is also intended to have a more general application to distribution systems for fresh fish which operate in other countries.

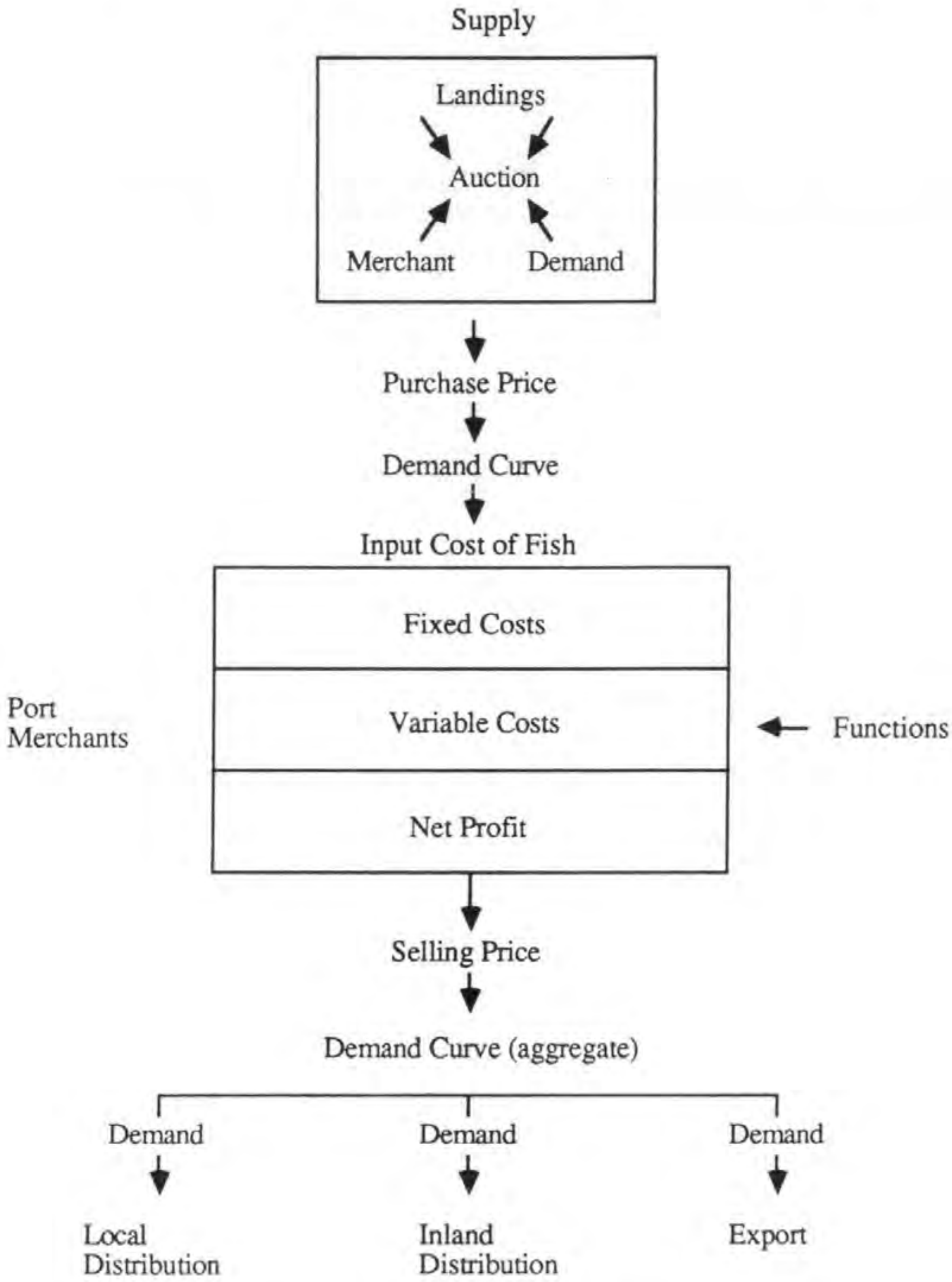
The principal features of the port merchant level of the system can best be described in terms of a series of economic relationships suggested by economic theory and the survey data presented earlier in this chapter. A schematic model of port merchant operation reflecting these relationships is shown overleaf in Figure 2.

The major contention here is that if one can formalise the main features of port merchant operation and represent them as a series of relationships, then one will have a method of analysing and predicting the effects of external changes upon the financial performance of the system.

For example, it is hypothesised that at auction, a series of demand and supply relationships exist, reflecting available supplies of fresh fish and port merchant willingness to purchase. It has already been suggested that supply of fish is one of the major variables that will influence the success of the port merchant sector. The view taken here is that supply is predetermined by factors on the fishing grounds rather than port merchant demand. This exogeneity in supply is important as it means that merchant demand responds to available supplies rather than determines them. These issues are dealt with in the next chapter, where a variant on traditional economic models of demand is developed and which has the ability to explain and forecast the effects of changing levels of supply and demand factors upon the purchase prices paid by port merchants, in other words, the major cost to the system. The method used will be econometric estimating techniques. The modelling of influences upon the major cost to the system by such techniques is important for several reasons. Firstly, successful estimation of models will enable one to see in quantitative terms, the extent to which external variables influence and explain movements in purchase prices of major

Figure 2

Economic Model of Port Merchant Operation



species. Secondly, successful estimation of structural relationships by econometric methods provide a sound basis from which to provide forecasts of future events.

The ability to relate external factors to the cost of fish to the system using demand theory is only one part of the situation facing the port merchants. In order to develop a model of port merchant operation, other factors need to be taken into account. In particular, to derive a complete picture of the costs incurred by port merchants, a model of the costs of performing functions is needed. This is developed in Chapter 8 where a model relating functional costs to output is derived from the sample data.

Similarly, a model is needed of the pricing method used by merchants to enable the determination of revenues and selling prices. This is also developed from the sample data and shown in Chapter 8.

Only a brief overview is given here as the model develops in the following chapters. However, the main argument is that the use of the sample data and econometric models of demand will allow the estimation of the major financial relationships in the system and provide a basis for estimating the impacts of a variety of external influences.

In closing this section, a few general points should be noted. Firstly, the overall model to be developed will concentrate on demersal species treated as a whole. As will be seen later, this is to provide for compatibility between the econometric models and the sample data. However, individual models of demand for the major species likely to become increasingly under external control (e.g. quota management) are also developed and are regarded as important, especially as a basis for future research. Secondly, the model focuses upon demersal species, partly because of their importance to the system and also for compatibility between data sets; shellfish are omitted from the model owing to the fact that only one merchant specialised in these species, the remainder dealing virtually exclusively in demersal species. Finally, the level of aggregation of the model is such that it aims to represent the majority of the port merchant system as a unified unit located at the three major ports of Plymouth, Newlyn and Brixham.

CHAPTER 6

AN ECONOMETRIC MODEL OF PORT MERCHANT DEMAND

6.1 Econometric Methods of Estimating Demand Functions

Traditional microeconomic theory suggests that the demand function for some particular good has the fully deterministic relation :

$$Q = f(P) \tag{1}$$

where Q = Quantity demanded

P = Price

This is the common demand function describing the behaviour of buyers in determining the quantity of some particular good that they are willing to purchase as a function of the price of that good. When the above relationship is expressed as a simple econometric model, it takes the following form :

$$Q_t = \alpha + \beta P_t + U_t \tag{2}$$

In this case, Q_t is quantity demanded in time period t, P_t is price in time period t, and U_t is an error term corresponding to shifts in the demand function. In general, the estimation of the demand function for a particular good in the form of equation (2) by the standard estimating technique of Ordinary Least Squares (OLS) would create serious problems. The most important of these is that a shift in the demand function changes not only quantity, but also price; therefore P_t and the error term, U_t, are correlated. The problem here is that this violates one of the fundamental assumptions of the OLS estimator, that the independent or determining variables are independent of the error term U_t, and would lead to biased estimates of the parameters of the equation (see Maddala G.S., 1977).

The essence of the problem can be seen in the following diagram :

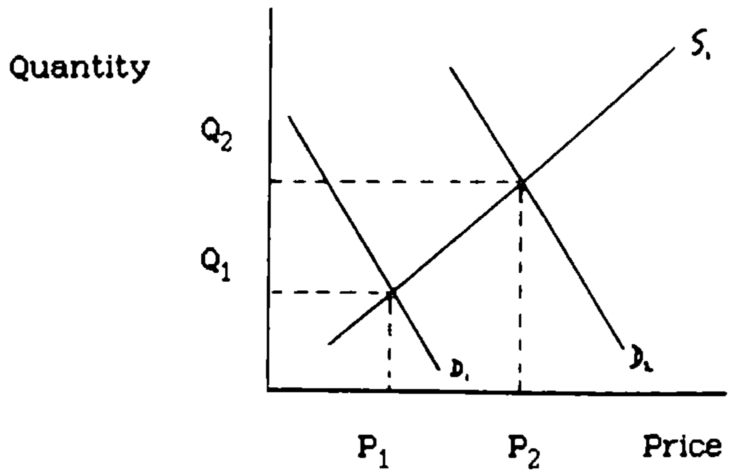


Figure 1 The Simultaneous Relationship Problem

Rather than dealing with a single relationship, one is dealing with a simultaneous relationship. As indicated above in equation (2), Q_t is not the only dependent or endogenous variable in the equation. As Figure 1 demonstrates, if the demand function shifts outward to the right, this not only results in an increase in quantity demanded but also an increase in the price paid. This rather suggests that one equation is being used to describe more than one relationship, for both Q_t and P_t are endogenous or jointly determined variables.

The normal solution in this case is to introduce a supply function into the picture to describe the behaviour of suppliers in determining the quantity that they are willing to supply as a function of price. To complete the model, a market clearing equation is often added to show that buyers and sellers settle instantaneously at equilibrium prices and quantities. The result is a complete model of a market as shown below :

Q_{dt}	=	$\alpha 1 + \beta_1 P_t + U_{1t}$	Demand function (2)
Q_{st}	=	$\alpha_2 + \beta_2 P_t + U_{2t}$	Supply function (3)
$Q_{dt}(P^o)$	=	$Q_{st}(P^o) = Q^o$	Market Clearing Equation

where :

Q_{dt}	=	Quantity demanded in time period t.
Q_{st}	=	Quantity supplied in time period t.
P_t	=	Price in time period t.
U_{1t}, U_{2t}	=	Error terms.
P^o	=	Equilibrium price.
Q^o	=	Equilibrium quantity.

While the simultaneous equation model in (3) represents a more comprehensive model of demand and supply reflecting the fact that both are determined simultaneously, any attempt to actually estimate a model of the above form based on actual observations on Q_t and P_t would still run into serious problems. For example, if one supposes that all other factors influencing demand and supply remained constant during the observation period and also that the error terms were always equal to zero, then all that could be observed under these conditions would be a single pair of values for Q_t and P_t. These values would be at the intersection point of the two curves $Q_{dt} = \alpha_1 + \beta_1 P_t + U_{1t}$ and $Q_{st} = \alpha_2 + \beta_2 P_t + U_{2t}$.

Even if the error terms were non zero and varied throughout the observation period, then in any one period all that would be observed would be the intersection point of two curves. Any scatter of points obtained throughout the observation period would merely be a series of intersection points generated by the continually shifting demand and supply curves. This is illustrated in Figure 2 below where D_1 and S_1 are the demand and supply curves for period 1 and so on.

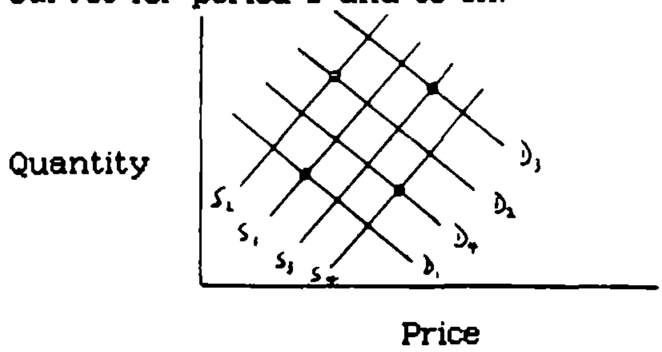


Figure 2 The Problem of Shifting Supply and Demand Curves

Clearly, any attempt to fit a line by methods such as OLS to such a scatter of points as in Figure 2 would neither be estimating the demand function nor the supply function, but rather what is sometimes called a "mongrel" equation containing elements of both (e.g. Thomas R.L., 1985). This is a simple example of the identification problem often found in the presence of simultaneous relationships.

In the context of the above example, identification of either function can only be obtained provided it remains stationary over the estimation period while the other function shifts. An example of the demand function being identified is illustrated in Figure 3 below :

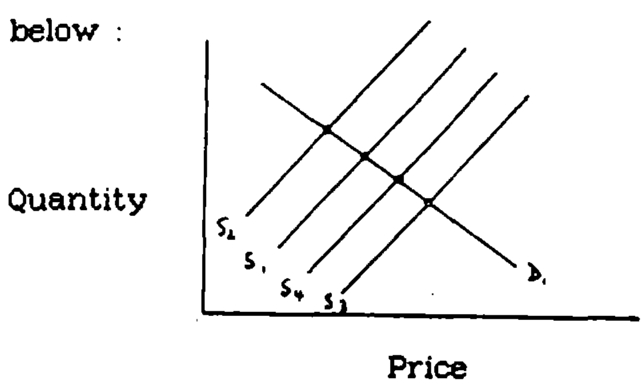


Figure 3 Identification of the Demand Curve

In this example, one can see that if the demand function remains stationary, it will be identified by the shifts in the supply curve. Such shifts in the supply curve might occur for two possible reasons. Firstly, the error term in the supply equation might vary from period to period while the error term in the demand equation remained very close to zero. A second and more plausible reason why the supply function shifts would be that the other factors determining supply were not in fact constant, but shifting around throughout the observation period.

In general, it is not possible to successfully estimate equations of the form in (3) above, as it is usually unrealistic to assume that one or other function remains stationary while the other shifts about. If the identification problem in this context is to be overcome, then variations in equilibrium price and quantity need to be explained by the appropriate introduction of exogenous variables which determine shifts in demand and supply.

For example, in equation (3) above, if we introduced a new income variable, Y_t, into the demand function to act as a demand shifter over time, then in principle the supply curve could be identified as the income variable shifts the demand curve enabling the supply curve to be traced out. Similarly, if one introduced a new rainfall variable, Z_t, into the supply function to act as a supply shifter (dropping Y_t from the demand equation for the moment), then in principle the demand function could be identified as the rainfall variable shifts the supply curve, enabling the demand curve to be traced out. As long as these new variables are truly exogenous (i.e. independent of the error term) and exhibit considerable variability, then the result stated by Baumol holds good :

"One of a pair of simultaneous relationships will be identified if it lacks a variable which is present in the other relationship." (Baumol W.J., 1973)

A simultaneous equation model in which both the demand function and the supply function are identified would be represented by the inclusion of the income variable in the demand equation and the inclusion of the rainfall variable in the supply equation. This model would take the form :

$$Q_t = \alpha_1 + \beta_1 P_t + \alpha_1 Y_t + U_{1t} \quad \text{Demand function}$$

$$Q_t = \alpha_2 + \beta_2 P_t + \alpha_2 Z_t + U_{2t} \quad \text{Supply function} \quad (4)$$

In equation (4) above, Qt and Pt are the jointly dependent or endogenous variables, while Yt and Zt are the exogenous or determining variables. Estimation of the structural equations in (4) by OLS would lead to biased estimators for the parameters, because P_t is correlated with the error terms U_{1t} and U_{2t}.

The necessary procedure to enable estimation is to solve the two equations in (4) for Q and P in terms of Y and Z and get :

$$Q = \frac{\alpha_1\beta_2 - \alpha_2\beta}{\beta_2 - \beta_1} + \frac{\lambda_1\beta_2 Y}{\beta_2 - \beta_1} - \frac{\lambda_2\beta_1 Z}{\beta_2 - \beta_1} + \text{an error} \quad (5)$$

$$P = \frac{\alpha_1 - \alpha_2}{\beta_2 - \beta_1} + \frac{\lambda_1 Y}{\beta_2 - \beta_1} - \frac{\lambda_2 Z}{\beta_2 - \beta_1} + \text{an error}$$

These equations are known as the reduced form equations can can be written as :

$$Q = \Pi_1 + \Pi_2 Y + \Pi_3 Z + V_1 \qquad (6)$$

$$P = \Pi_4 + \Pi_5 + \Pi_6 Z + V_2$$

$$\text{Where : } \Pi_1 = \frac{\alpha_1\beta_2 - \alpha_2\beta_1}{\beta_2 - \beta_1}, \qquad \Pi_2 = \frac{\lambda_1\beta_2}{\beta_2 - \beta_1} \quad \text{etc.}$$

These equations can be estimated to obtain unbiased estimates of the parameters, from which the structural co-efficients of the structural equations can be determined. The particular estimating techniques used in this situation depend upon the degree of identification possible; however, Indirect Least Squares (ILS) and Two Stage Least Squares (TSLS) are common methods.

6.2 Application of Econometric Methods to the Demand for Fish

Most econometric works (see Cramer J.S., 1971) hold that as a result of the simultaneous determination of supply and demand, that statistical approaches to the estimation of demand relationships must take the general form of the equations in (4) above. The use of single equation models in the presence of simultaneous relationships will lead to problems of bias as discussed above. In addition, the identification problem needs to be considered explicitly within a model; failure to do so would generally produce meaningless parameter estimates, as one could not be sure if one were estimating a demand function or some other function.

While a simultaneous equation model constitutes the most plausible and comprehensive representation of market demand, there are however, two particular situations where single equation estimation by OLS is appropriate (Thomas R.L., 1985; Cramer J.S., 1971; Klein L.R., 1962). It is argued below that one of these situations can be developed to form an appropriate representation of the demand and supply relationships facing the port merchant sector in the South West.

The first of these special cases is where own price is a predetermined variable. For example, this is the case with some public utilities such as gas and electricity where price tends to be set independently of market conditions by public regulation. Such a situation is depicted below :

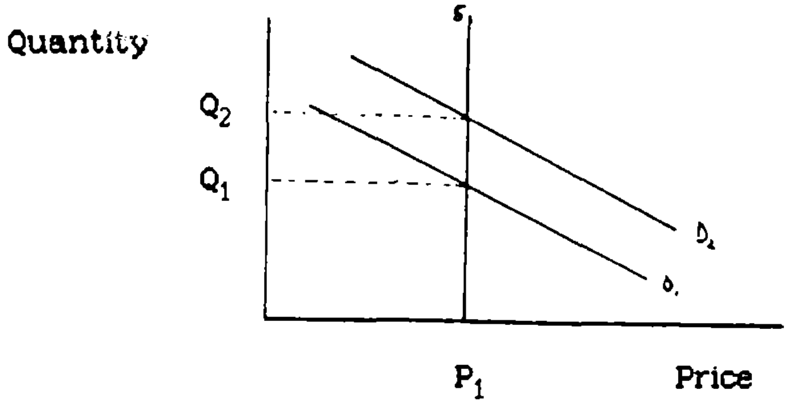


Figure 4 A Market with Perfectly Elastic Supply

The market model shown in Figure 4 is one which operates with a perfectly elastic supply curve, S_1. In such a case as this where price is set independently of quantity demanded, one can see that a shift in the demand function from D_1 to D_2 results in an increase in quantity demanded but price remains the same at P_1. In the context of equation (2) above, single equation examination by OLS is now appropriate as P_t and U_t are independent and the problem of simultaneous equation bias is negated.

The second of these special cases where single equation methods are appropriate occurs where supply itself is a predetermined variable. If this is the case, then the supply equation in (4) above can be replaced by the simple statement :

$$\overline{Q}_t = \overline{Q}^o = \text{predetermined by independent factors}$$

where $\overline{Q}_t$ = current quantity

$\overline{Q}^o$ = equilibrium quantity.

Having replaced the supply equation with the above statement, one is left with the demand equation of (4) above :

$$Q_t = \alpha_1 + \beta_1 P_t + \lambda_1 Y_t + U_{1t}$$

However, Q_t can no longer be considered the dependent variable, as it is now predetermined or exogenous. The only endogenous variable is own price, P_t. The obvious procedure is to rewrite the above demand equation with the endogenous own price as the dependent variable :

$$P_t = \frac{\alpha_1}{\beta_1} + \frac{(1)}{(\beta_1)} \overline{Q}_t - \frac{(\lambda_1)}{(\beta_1)} Y_t - \frac{U_t}{\beta_1} \qquad (7)$$

Since all the explanatory variables in equation (7) are either exogenous (Y_t) or predetermined ($\overline{Q}_t$), they can be considered independent of the error term U_t/β_1. This being the case, then the application of OLS to equation (7) will yield unbiased estimates of its parameters. The situation of the model in equation (7) is known as a market that operates by price adjustment as opposed to one in which price is set and quantity varies, or one in which price and quantity are simultaneously determined. The parameter $(1/\beta_1)$, rather than being the price elasticity of demand is in fact the inverse and is known as the price flexibility of demand measuring how price responds to changes in quantity (Cramer J.S., 1971).

The model of demand in equation (7) can be demonstrated diagramatically as in Figure 5 below :

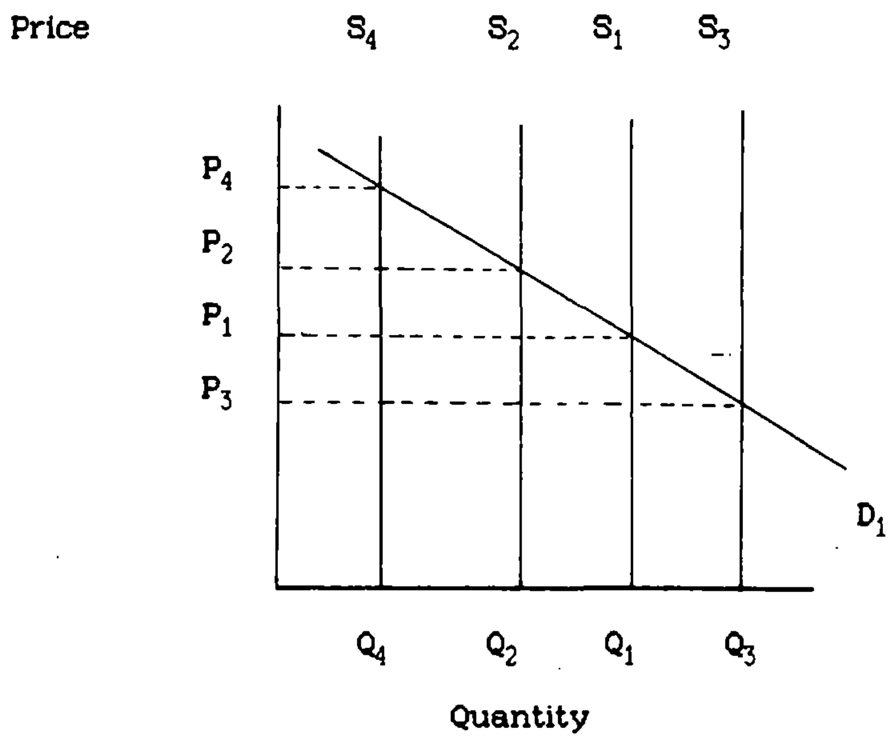


Figure 7[1] **A Market with Perfectly Inelastic Supply**

One can see in the above model that supply is perfectly inelastic and fixed in any one period. In this model, demand in no way influences supply, rather demand responds to the predetermined supply in terms of the prices paid for different levels of supply.

This type of model has often been considered as a valid specification in studies of the demand for perishable agricultural commodities (Thomas R.L., 1985). The supply of such commodities is subject to exogenous weather variations and in many cases can be considered to be virtually totally inelastic with respect to current price because of time lags involved in the planting, growing and harvesting of perishable commodities. Single equation

1. Due to the fact that price not quantity is now the dependent variable, quantity has been replaced by price on the vertical axis in line with statistical convention.

models, such as equation (7), have also been used in investigating the demand for fish at both the retail and wholesale levels (e.g. Allan C.M., 1973; Young T., 1976; Colman D. and Young T., 1970).

In the last section of the previous chapter, it was stated that the key variable which needed explaining and forecasting was the purchase price paid by port merchants for their supplies of fish. An obvious attraction of the model form of equation (7) is that it is price rather than quantity which acts as the dependent variable. However, before the general form of model discussed above can be taken to be a valid representation of the wholesale demand of port merchants, there are a large number of assumptions and conditions about this model form which need to hold.

The first point to be made (which would apply to simultaneous equation models as well), is that successful estimation of demand relationships requires that prices observed are equilibrium prices representing points of intersection on the demand and supply curves, and determined on the basis of market clearing. For many products, prices are not likely to be equilibrium prices, for as Allan observes :

> "Stocks are normally being increased or decreased and queues are common." (Allan C.M., 1973).

However, in the case of the market for demersal species in the South West, there are several reasons for supposing that actual prices do in fact approximate equilibrium prices. At the major ports of Plymouth, Newlyn and Brixham, each day's demersal catch is mainly sold by auction and market clearing takes place. Prices paid by port merchants for fish landed directly to them are likely to approximate those at the auction for reasons given in the previous chapter. Several pieces of supporting evidence for market clearing can be put forward. Firstly, no market support arrangements in the form of a withdrawal price system exist for demersal species in the South West; therefore prices are not distorted. Secondly, the major co-operative in the region, acting in the role of port merchant and as the major auctioneer, guarantees a sale to the fishermen members of the co-operative who form the principal suppliers, thus facilitating market clearing.

Another factor which could distort market clearing and the reality of equilibrium prices is the presence of stocks. The survey work of the last chapter demonstrates that the major buyers at auction, the port merchants, do not keep stocks; fresh demersal species are purchased daily, for distribution later the same day. Virtually no freezing, processing or holding stocks of major demersal species occurs.

Even if one accepts that equilibrium prices do exist, this is only a necessary condition for the estimation of demand relationships, not a sufficient one. Allan has postulated a further set of conditions, which he argues must be met before single equation methods can be applied (Allan C.M., 1973) :

1. A highly perishable product.
2. A unified market.
3. An homogenous and divisible product.
4. Adequate accurate statistical information.
5. Supply which varies in response to exogenous influences.
6. Demand which remains constant for long enough to enable a sufficient number of observations to be made.

It is argued below that to a greater or lesser extent, these conditions are met in the case of the wholesale market for demersal fish, thus facilitating the use of single equation estimating techniques.

Firstly, it goes without saying that fresh demersal fish is a highly perishable product. Most demersal species can tolerate chilled storage overnight, while awaiting the auction the next morning. For prime demersal species such as Dover Sole, Monkfish, Hake, Lemon Sole and Plaice, it is important that they are sold as quickly as possible after landing and handled as little as possible, in order to avoid quality deterioration. It has long been held that the auction system is the most effective and the quickest method for ensuring market clearing of such a perishable product (e.g. Taylor R.A., 1960).

The importance of the second condition for single equation estimation techniques lies in the fact that if a unified market exists, then a change in landings of a particular species may be expected to have the same effect on prices irrespective at which port it occurs. The important point here is that the degree of market unification effectively defines the level of aggregation of the analysis. For example, if market demand conditions were different at the major ports in the South West, then separate models would have to be specified for each port. If one can demonstrate that the three ports of Plymouth, Newlyn and Brixham constitute a unified market, then the level of analysis can be aggregated to a single set of demand conditions encompassing all three ports.

Considerable support for the tenet that the demersal fish market is unified can be put forward. Firstly, apart from the close proximity of the ports, they are also linked by effective telecommunications. Secondly, merchants at the ports tend to concentrate upon the same types of species, as seen in the previous chapter. In addition, the previous chapter demonstrated that port merchants located at one port purchase supplies from the auction at the other ports in the South West, and trade with port merchants located at other ports. The principal co-operative, based at Brixham, is a major daily buyer at the other ports of Plymouth and Newlyn.

Homogeneity of a particular species assumes importance, as it can then be regarded as one distinct standardised product with one set of demand condititions prevailing. From the fish purchasing point of view, homogeneity can be discussed in terms of quality variation and size variation. Firstly, for some species there exists some variation in quality over the year. For example, it is well known in the local industry that at certain times of the year, Monkfish is of a lower quality due to spawning, with the flesh losing some of its firmness. One might reasonably expect that such quality variations on a seasonal basis are reflected in the seasonality of demand. For example, it would seem logical to hypothesise that at times of the year when quality of a particular species is high, that demand for that species would also be high.

The other aspect of homogeneity of species relates to size variation. If all species had only one grade each, then one could hypothesise that for each species, only one demand function was needed. Unfortunately, most species have more than one grade and consequent price differentials. For example, Dover Sole has four grades, Hake usually has up to five and Lemon Sole three. The prices paid at auction for different grades of the same species can vary alarmingly as the range of prices paid for Dover Sole at the beginning of March 1983 given below demonstrates :

TABLE 1 Dover Sole Prices for Different Grades

Grade	Price (£)
Large Sole	14.70
Medium Sole	25.30
Slip Sole	16.50
Tongue Sole	13.20

(Source: Devon Sea Fisheries Committee Quarterly Report, July 8th 1983).

In addition to price variation between grades, as one can see from Table 1, it is not always the largest grade which commands the premium price. The same pattern is found in some other species, e.g. Plaice. The implication of this finding is that ideally one should specify separate demand equations for each grade of the same species, for as the above table indicates there is no reason for supposing that exactly the same set of demand conditions prevail for different grades of the same species. Demersal species are divisible products, with port merchants able to purchase as much or as little as possible thus facilitating market clearing.

It would appear from the above that it would be erroneous to assume that demersal species are homogeneous with respect to quality or size variation. The way in which this problem was handled is dealt with later in this chapter as is the discussion of the fourth condition of adequate statistical information.

The last two conditions are in many respects the most fundamental to the usage of single equation methods. Condition five postulates that supply needs to vary in response to exogenous factors. The principal issue here is that supply needs to be predetermined by exogenous factors so that it can be treated as perfectly inelastic with regard to demand and price. If this condition is not met, then a shift in demand will have some effect upon supply and one is likely to encounter the problems of simultaneous equation bias, as discussed earlier.

The question of whether fish supply is inelastic or not has interested several authors (Allan C.M., 1973; Taylor R.A. 1960). They suggest that daily supplies are in fact determined by demand. The classic example is the habit of eating fish on Fridays leading to increased fishing effort on Thursdays so that the fish can be in the shops for Friday. However, Ritson et al. report that this habit has been in decline since the war, thus reducing the effect (Ritson C. et al., 1982). Even if there were a marked effect here, it is much more likely to be pronounced at ports where the traditionally popular Cod and Haddock still form a large percentage of the demersal catch. It is unlikely that the supply of the principal South West species is subject to this demand effect, for the additional reason that a large percentage of their supply is exported by port merchants.

Moving from the possibility of this very short run effect to the longer term, it is highly probable that the assumption of an inelastic supply would break down. For example, it is quite likely that longer term trends in demand reflected in price movements of a particular species will influence supply as fishing effort moves away from species with falling or static demand towards those species which might be increasing in demand. A good example here is the increased effort on Monkfish in the South West as a result of the demand from the Continent and in particular France and Spain, which has resulted in increased landings over the 1978-1982 period (see Appendix 2). In the longer term price signals can work their way back through the system to the fishermen and influence supply. Similarly, in the longer term fishermen are able to adjust and change their patterns and methods of fishing in view of trends in demand.

The implication of this for single equation estimation, is that if one were to estimate short run models based upon daily observations on price and quantity, there is a possibility of simultaneous equation bias. Similarly, if one estimated models based on annual or even quarterly data, there is a likelihood of simultaneous equation bias. For the inelastic supply assumption to be valid, it is important that the observations used in the estimation of models are of a time period short enough to avoid demand factors affecting supply and yet long enough to avoid the possibility of short run effects.

It was determined that monthly observations on price and quantity would be most likely to validate the inelastic supply assumption. With regard to the longer term influence of demand upon supply, it is unlikely that fishing vessels could respond to current monthly prices due to the time lags involved for price signals to work back through the system from consumer to fishermen. In addition, even if fishermen were willing to respond to price signals, the necessary changing of fishing gear, method and fishing grounds would provide a further obstacle. For reasons such as these, it seems reasonable to suggest that current monthly quantities are independent of current monthly prices.

Having argued that current supply is inelastic with regard to current price, it is necessary to specify the predetermined nature of supply. The supply of demersal fish depends upon factors which can be regarded as truly exogenous to demand in the short run. Many biological factors can affect supply levels: previous year classes, stock biomass, migration patterns. The number of fishing vessels, the weather, technology and fuel costs are also important.

In recent years, quota levels set for important demersal species have also determined the absolute level of supply available. Quota levels, in fact, serve to reinforce the inelasticity of supply with respect to demand.

The final postulated condition is that of a constant demand over the estimation period. It is rather unrealistic to expect demand to remain constant over any considerable time span. It has already been suggested for example, that in the South West in recent years the demand for Monkfish has increased. The question of whether demand remains constant or not, is not really the issue; the central point is, providing that one's assumption about the exogenous supply holds, then in the context of single equation estimation demand needs to remain more stable than supply, thus enabling identification of the demand curve rather than the supply curve. The principal case where demand would need to be constant would be if no factors causing shifts in the demand curve were included on the right hand side of the equation, and thus relegated to the disturbance term.

One would reasonably expect, in an industry which basically depends upon hunting, that supply would exhibit a considerable degree of variability, which is likely to cause movements along a particular demand curve. Similarly, one would expect demand to shift, but in a more gradual fashion. Tastes and preferences change; substitution effects occur; new markets may develop or may decline. These and many other factors are likely to cause shifts in the demand curve, but on a monthly basis, one would expect these changes to be more gradual than the variations in exogenous supply. While one would expect demand to shift, particularly over time, one would not expect such shifts to be as marked as changes in supply. It would appear appropriate when specifying the estimating equations to include factors causing shifts in the demand curve as explanatory variables where relevant.

It has been argued above that the demand and supply conditions facing port merchants fulfil many of the necessary conditions which allow the single equation approach to the estimation of demand relationships for major demersal species. The assumptions which have been made in this section will be re-examined in the light of the estimation results in Chapter 7. Where asumptions have not been justified, allowance must be made in the different model specifications to which we now turn.

6.3 Model Specification, Data and the Issue of Seasonality

6.3.1 Specification

Before any individual models could be specified, it had to be determined for which species single equation models of port merchant demand were to be formulated. Three criteria were used; those species deemed most important by port merchants in the sample; those species which were most important in value terms at the three ports of Plymouth, Newlyn and Brixham in 1982; and finally those species for which annual quotas are set. On the above basis, five individual species were selected for analysis: Dover Sole, Monkfish, Hake, Lemon Sole and Plaice. Of these five, all were rated highly by port merchants in the sample; in value terms, the five species account for over 63% of the total value of demersal species landed at the three ports in 1982; finally, quotas are set annually with the exception of Lemon Sole. It was also decided to formulate another more aggregated model for all demersal species. This model aggregates all species together and effectively treats them as one distinct species, with an aggregated set of demand conditions. This model was seen to be important as it has already been discussed that sample cost data relates to demersal species as a whole. This being the case, it is essential that a model of demand based upon demersal species as a whole is estimated and used for forecasting in such a way as is compatible with the sample cost data.

The following models are not specified at the port level. It was argued in the previous section that there are sound reasons for regarding the markets for demersal fish at Plymouth, Newlyn and Brixham as a unified market. Therefore, for each species one equation is specified covering all three ports.

The following general model specification was put forward for each species :

$$P_{it} = \alpha_1 + \beta_2 Q_{it} + \beta_3 P_{jt} + \beta_{4t} + u_t \quad (1)$$

where P_{it} = Price of the ith species in time period t.

Q_{it} = Quantity of the ith species in time period t.

P_{jt} = Price of the jth species in time period t.

t = A time trend.

u_t = An error term.

In the above model, price is expressed as the average price in time period t per stone. Quantity is expressed in stonnage terms. The use of stonnage as the unit of quantity is appropriate as demersal species are still auctioned by the stone rather than the metric system. It is hypothesised that price is inversely related to own quantity as suggested by conventional demand theory. The price of the jth species is included in the model for individual species to represent the effects of substitutes. One might reasonably hypothesise that in a market where supply is fixed in the short term, that there are interrelationships between species. In some cases, species are similar and are distributed through the same distribution channels. In cases when fixed landings of one particular species are very low and demand is high resulting in high unit prices, merchants may attempt to purchase supplies of other similar species thus increasing demand for these species. For this reason, it is hypothesised that the substitute variable P_{jt}, acting as a demand shifter for P_{it}, is positively related to P_{it}.

The final explanatory variable included in equation (1) is a time trend, included to explain longer term trends in demand resulting from the many possible factors which could cause shifts in demand such as changing tastes, changes in income or changing markets. While wholesale port merchant demand is a derived demand from the consumer, and is therefore possibly affected by the many factors which influence consumer demand such as income and prices of goods other than fish; it is very difficult to determine specific demand shifters which are relevant. For example, one might hypothesise that the retail price of Chicken shifts the derived wholesale demand for a particular species. However, if that particular species is distributed locally within the South West region, distributed inland to the rest of the country and exported, one has difficulty in determining the appropriate retail price of Chicken to act as a demand shifter. It is for reasons such as this, that the time trend is included to act as a universal demand shifter, rather than include possibly meaningless specific variables.

Following on from the discussion of size variation of species in the last section, it was also hypothesised that the general form of equation in (1) should be estimated for the different grades of the same species. In this case, price would be the price of a particular grade and quantity would be the quantity of that grade. Substitute price would be expressed as an average of all grades of that particular substitute to reflect the problem of determining which particular grade is the most likely to have an effect.

One further assumption that needs to be stated, is that the independent variables are assumed to be a linear function of the dependent variable, price.

The specific model for each species took the general form of equation (1) above, although it was hypothesised that there would be some differences between the models, principally with regard to the determination of the appropriate substitute species.

In the Dover Sole model, it was hypothesised that Monkfish would be the appropriate substitute variable. Both species are predominantly purchased by port merchants for export distribution mainly to France. It is a reasonable hypothesis to suggest that in a market with a fixed supply, these two species are likely to some extent to be in direct competition. Export merchants seeking to maintain overseas customers may react to shortfalls in Monkfish landings by increasing demand for Dover Sole, thus the price of Monkfish is included to represent this effect.

Owing to the fact that the vast majority of Dover Sole purchases are exported principally to France, it also seemed reasonable to suggest that the strength of demand at wholesale markets in France for Dover Sole would influence demand in the South West. For this reason, an additional variable representing the price of Dover Sole at major French markets was included. This variable was specified in the current time period, rather than lagged, to represent the close telecommunications that exist between French and South West ports.

The Monkfish model follows the above logic closely. Dover Sole price was specified as the substitute variable. Here it is hypothesised that shortfalls in Dover Sole landings will result in higher Dover Sole prices, causing merchants to shift the demand for the other major export species, Monkfish. The converse also holds, large landings of Dover Sole resulting in lower prices may exert a downward shift on the demand for Monkfish. One potential problem here is that in the Dover Sole model, Monkfish is hypothesised to explain movements in the price of Dover Sole, yet Dover Sole is also included in the model for Monkfish. It may be that this specification is best treated in a simultaneous framework with lagged relationships. This problem is returned to in the next chapter after the single equation model results have been discussed.

Due to the fact that Monkfish is primarily exported to France, a variable representing the current price of Monkfish at major French wholesale markets was included.

Hake is a species principally exported to Spain, and for that reason a Spanish wholesale Hake price was included in the model. The determination of the most appropriate substitute was more difficult as it is not clear if there are any relatively close substitutes for Hake. Nevertheless, owing to its overall importance in the wholesale market, and its importance as an export species, the price of Dover Sole was included. (As with the above models, the Spanish wholesale price of Hake was included.)

In the Lemon Sole model, the price of Plaice was included as the substitute variable. There are two main reasons why: firstly, although Lemon Sole commands a higher unit value than Plaice, the two species are very similar in many respects both being flatfish of similar size and texture. In addition, while both are exported, they are primarily distributed inland to the major inland wholesale markets. For this reason, it is reasonable to suggest that Plaice would be the most appropriate substitute variable. Another variable deemed to be important was the inland wholesale market price of Lemon Sole. When distributed from the South West to the major inland markets such as Billingsgate, Lemon Sole is in direct competition with the same species which has been delivered from other ports and which has been imported. Clearly as the merchant demand is a derived demand, the inland market price of Lemon Sole will exert an influence upon the demand conditions in the wholesale market in the South West. The appropriate variable included was the Billingsgate price of Lemon Sole in the current time period.

The above logic can almost identically be applied to the Plaice model. It too is distributed inland and is in competition with other supplies of Plaice, therefore the Billingsgate price of Plaice is included. Similarly, the substitute variable is the price of Lemon Sole for reasons discussed above.

The demersal model was a much simpler affair. In specifying a model in which all demersal species are treated as one, it is not clear that any substitute variable is appropriate. Shellfish and Pelagic species tend to bypass the auction and are not generallly handled by port merchants who tend to specialise in demersal species. For this reason no substitute variable was included in equation (1). The complexity of distribution of the different demersal species make it impossible to determine other relevant demand shifters.

6.3.2 Data

A fundamental requirement of any econometric analysis is the existence of a consistent and accurate data set. For the models specified in the previous section, the data requirements were considerable. Firstly, the data series had to be long enough and consistent to enable estimation. Secondly, data was required for a great many variables, and at a great level of disaggregation.

With regard to obtaining data series of price and quantity for the different grades of the same species, great problems were encountered. Data for the prices of different grades existed, but in sporadic form. The Chief Fishing Officer's quarterly reports to the Devon and Cornwall Sea Fisheries Committees provide auction price data for different grades of the same species for the major ports. Two problems exist however; firstly, it is not clear whether these prices are daily, monthly or quarterly. Secondly, the data is not consistent, the same prices do not appear in consecutive reports.

A further problem was that no quantity data for different grades of the same species was available from any source.

The only consistent data series were the monthly observations on quantity and value for individual species obtainable from the M.A.F.F. local offices based at Plymouth and Newlyn covering the aforementioned ports and also Brixham. Since this data constitutes the most disaggregated and consistent series, it was decided that it would form the basis of estimation of the various models. The possibility of estimating different demand functions for different grades of the same species had to be rejected. Instead the price variable would now be an average covering all different grades.

Monthly data on quantity and value for total demersal, Dover Sole, Monkfish, Hake, Lemon Sole, Plaice was collected from January 1978 up until December 1982, the most recent data available at the time of estimation. It was felt that a five year period consisting of sixty observations was sufficient to enable estimation.

The quantity data was expressed in tonnes per month. This was converted into tons and then into stones per month, as these are the units in which demersal species are still purchased. The total monthly value of landings was then divided by the quantity to form an average monthly price per stone for each species, an approximation of the purchase price paid monthly by port merchants. The final stage in preparing the data was to remove the effects of inflation from the price series by the use of a retail fish price index. The result is the data series for each species found in Appendix 2.

The other data requirements were for monthly observations on price for Dover Sole and Monkfish at French ports and Hake at Spanish ports. Unfortunately, it was not possible to obtain the necessary data with the result that these variables had to be excluded from the respective models.

Somewhat surprisingly, a similar problem was encountered with regard to data on inland market prices for Lemon Sole and Plaice. The publications Fishing News and Fish Trader both publish weekly price ranges of both species at Billingsgate. Again the consistency problem became evident, as over the estimation period 1978-1982, on several occasions prices for both Lemon Sole and Plaice were missing. The result again was the exclusion of these variables.

The final variable in the equations is the time trend, which is simply a series measuring from 1 in January 1978 to 60 in December 1982.

While data availability led to the exclusion of certain variables, the data series on price and quantity was sufficient to enable estimation. However, before the equations could be estimated, preliminary data analysis revealed an additional problem which could not be ignored, this was seasonality in the price and quantity data.

6.3.3 Seasonality

The phenomenon of seasonality has been alluded to implicitly rather than explicitly already within this chapter. When discussing the assumption of homogeneity of species it was mentioned that quality may vary throughout the year for certain species. Consideration of Figures 1 and 2 in Appendix 3 indicate that seasonality is not a minor factor, but rather a very dominant characteristic of some species. Figure 2 showing the five year monthly average for quantity of Lemon Sole demonstrates that there is a distinct seasonal pattern throughout the year. Landings of Lemon Sole are very high in the first four months of the year; thereafter, landings consistently fall away until they bottom out in December and November. There are many biological and stock parameters which may lead to this seasonal pattern in landings along with other environmental factors.

The problem is complicated by the fact that, as Figure 1 shows, the five year monthly average price for Lemon Sole also exhibits a strong seasonal pattern. In fact the data for most of the models exhibits seasonality to differing degrees, either in price, quantity or both, as can be seen in Appendix 3. Lemon Sole was chosen to illustrate the discussion due to the clarity of the patterns. It can be seen from Figure 1 that the seasonal pattern in the price of Lemon Sole is different to that of quantity. Price is high at the beginning and the end of the year with a period of low prices intervening.

It is obvious that when the price and quantity data exhibit such pronounced seasonal patterns, one cannot ignore them. The question is then, how should this phenomenon be treated within the context of the single equation specification?

One possibility of course, is that if both the price and quantity data exhibit pronounced variation, then the single equation specification is an invalid representation of the relationship behind the data movements. For example, if the seasonal peaks in quantity tend to correspond to the seasonal peaks in price, then one connotation could be that fishermen are responding to price signals and catching more of that particular species. If this is the case, then there is a need for simultaneous equation estimation. However, the view taken here is that seasonal peaks in supply depend very much more upon biological and environmental factors rather than purely a demand effect, and that the predetermined supply assumption holds.

In many respects, this question is one of causality; whether the causality runs from demand to supply or whether it runs from supply to demand. Where one finds seasonal peaks in both quantity and price, it is more likely that merchants respond to seasonal peaks in landings of different species by attempting to orientate their buying behaviour towards those species in times of good supply. In other words, there is a seasonal effect in demand which matches that of supply. With the exception of Dover Sole (Appendix 3) the graphs do not tend to confirm the coincidence of peaks in supply or price.

For some species, the seasonal peaks in price and quantity tend to move in opposite directions. This can be seen from Figures 1 and 2 where price is lowest in the middle of the year, during and just after the seasonal peak in quantity. This tends to confirm the view of traditional microeconomics, that supply and demand move in opposite directions. In other words seasonal peaks in supply resulting in good landings tend to result in lower prices; i.e. supply increases cause a shift downwards along the demand curve. There are other possible reasons for the seasonal patterns in price.

Seasonal peaks in price may be the result of exceptionally good quality fish in that particular month; or may be the result of an exceptionally good size distribution concentrated upon the premium grade of species. Finally, of course, seasonal movements in price might purely be demand caused and independent of any supply effect.

One can see that potentially there exists a morass of possibilities which may cause seasonal movements in supply and price. Having argued that seasonality does not invalidate the predetermined supply assumption, the problem still remains as how to encompass it.

Many econometric texts (e.g. Maddala G.S., 1977; Johnston J., 1984; Wonnacott R.J. and Wonnacott T.H., 1970) suggest that for the purposes of estimating structural relationships by regression analysis then seasonal variation should be removed from the data before estimation proceeds.

The usual procedure adopted, as reported in most econometric texts (e.g. Pindyck R.S. and Rubinfeld D.L., 1981) is to smooth the data by the ratio to moving average technique. However, usage of this method has been criticised for removing more than seasonal variation from the data (Thomas J.J. and Wallis K.F., 1970) and also for not recognising the degrees of freedom loss implicit in such a procedure.

Other authors (e.g. Johnston J.J., 1984) suggest that a regression procedure is more appropriate. The basis of this procedure is to regress each individual data set on a matrix of dummy variables to represent seasonality and a set of polynomials of time to represent the trend and cycle components of the data series. The idea here is that the residuals from one of these models would be free of trend, season and cycle, and when added back to the mean of the original data series would constitute a deseasonalised data set. In addition, one has the knowledge of the degrees of freedom loss in such a procedure.

Considerable thought was given to the possibility of deseasonalising the various price and quantity series due to the complex nature of the seasonality. However, it was soon realised that this would prove an unwise procedure for the following reasons. Firstly, where price and quantity are related to each other through the standard demand relation, to attempt to deseasonalise one data set independently of the other would be difficult. If we specified a purely seasonal model of price and then took the residuals, they would appear still to be seasonal as quantity had not been included in the equation. One would never be able to determine whether one data set had been satisfactorily deseasonalised. A second and more fundamental reason for not removing seasonality is that the resulting structural model when used for forecasting would produce deseasonalised forecasts for what is known to be a seasonal variable price.

For these reasons, it was determined to attempt to explain seasonality within each individual model.

Thomas and Wallis (Thomas J. J. and Wallis K.F., 1970) suggest that seasonality can be ignored in some instances. The principal case being when the seasonality in the dependent variable is entirely the consequence of seasonal influences acting through the explanatory variables. In this case, if the seasonality in price is solely explained by seasonal variations in quantity, then there is no need to include seasonal variables in the equation. in the case of Lemon Sole (Figures 1 and 2) and some of the other species (Appendix 3), there is some evidence that seasonal variations in supply are associated with an inverse movement in price. In addition, the non-homogeneity of species, either in terms of quality or size variation may cause seasonal movements in price. however, it was also mentioned that there may be seasonal movements in price which are caused by demand independently of supply. This being the case, seasonal variables should be included rather than excluded.

The above considerations led to the revised specification of the general model below :

$$P_{it} = \alpha_1 + \beta_2 Q_{it} + \beta_3 P_{jt} + \beta_4 t + \beta_5 D_1 - \beta_{15} D_{11} + Ut \quad (2)$$

where P_{it} = Average monthly price per stone of the ith species.

Q_{it} = Monthly stonnage of the ith species.

P_{jt} = Average monthly price of the jth species.

t = Time trend.

$D_1 - D_{11}$ = Seasonal dummy variables, February to December (D_1 = February).

U_t = An error term.

The above model specification is fundamentally a seasonal model. The seasonal variables are included to explain seasonal movements in price, whether they are supply or demand related. Own quantity then explains variations in price which are not the result of seasonal influences in the conventional manner. The other variables are as before.

Two final points should be made here. Firstly, it was decided to use a dummy variable for each month, despite the fact that for some species, e.g. Lemon Sole, price seasonality can be split into two quite distinct periods. The reason here is that while different months may appear similar, they are not exactly the same and do vary from year to year, therefore a variable for each month should be included. Secondly, it is tempting to specify dummy variables only for those months which appear to have a pronounced seasonal pattern, thus saving on degrees of freedom. However, this would be an erroneous procedure, as the phenomenon of seasonality should be tested by the inclusion of all seasonal variables (Pearson J. M., 1983).

Having discussed the model form, and in particular re-specified the models in the light of seasonal influences, the next stage is to determine how well the models perform when estimated. This forms the content of the next chapter.

CHAPTER 7

RESULTS, FURTHER ESTIMATIONS AND FORECASTING

7.1 Results

The results presented in this section were estimated by the Ordinary Least Squares technique. The computer programme used was the Minitab Interactive Statistics package.

Each model was subjected to a generalised differencing procedure to correct for the presence of autocorrelation. It became apparent from the Durbin-Watson statistics, resulting from initial estimations, presented below in Table 1 that the null hypothesis of serial independence has to be rejected.

Model	Durbin-Watson Statistic
Dover Sole	0.93
Monkfish	0.97
Lemon Sole	1.00
Plaice	1.17
Hake	0.97
Demersal	0.97

TABLE 1 The Presence of Autocorrelation

A visual inspection of the residuals for each model confirmed the presence of autocorrelation. The correction procedure adopted was that developed by Cochrane and Orcutt (for example see Maddala G.S., 1977, page 278). It was assumed that the error terms in the models, rather than being serially independent, followed a simple first order autoregressive process of the form :

$$U_t = PU_{t-1} + V_t \qquad (1)$$

where

U_t = current error term.

U_{t-1} = error term lagged one period

P = rho, the autocorrelation coefficient

V_t = an independent error term.

This model was then applied to the residuals from the original models to obtain an estimate of the autocorrelation coefficients, which are shown below :

Model	**Autocorrelation coefficient**
Dover Sole	0.4906 *
Monkfish	0.4939 *
Lemon Sole	0.5001 *
Plaice	0.4045 *
Hake	0.5017 *
Demersal	0.3749 *

* significant at the 0.05 level.

TABLE 2 Estimated Autocorrelation Co-efficients

For each model, one can see that the residuals are not serially independent, with the previous months residual important in determining the current month. In order to correct for the autocorrelation, the following model was postulated for the price and quantity variables in each equation, the time trend and the dummy variables remaining in their original form.

$$P_{it} - \hat{p}\, P_{it}-1 = \alpha_1(1 - \hat{p}) + \beta_2\,(Q_{it} - \hat{p}\, Q_{it} - 1) +$$
$$\beta_3\,(P_{jt}-\hat{p}\, P_t - 1) + \beta_4 t\,(1-\hat{p}) \text{ etc.} \qquad (2)$$

The results presented here are all based upon models estimated in the form of (2) above. It was found in all cases that one iteration was sufficient to remove the autocorrelation, as successive iterations provided very small and insignificant estimates for $\hat{p}$. In the above equation, the transformed variables provide estimates of the original parameters. In order to obtain estimates of the original parameters for the untransformed variables, it is necessary to divide through by $(1-\hat{p})$.

When dealing with seasonal time series, there is also a possibility that higher order autocorrelation may be present, where previous seasons affect the present season. For this reason, residual models of the form of (1) above were estimated where the lagged residual corresponded to the same month in the previous year. However, estimates for $\hat{p}$ were insignificant.

7.1.1 Dover Sole

The results from the Dover Sole model are presented overleaf in Table 3.

The relationship between the dependent variable, price and own quantity has the expected negative sign, although surprisingly this variable is not significant at the 95% level. An illustration of the partial relationship between price and own quantity is depicted in Figure 1 for a range of quantities and demonstrates the downward sloping demand curve for Dover Sole. A clearer picture of the relationship between price and quantity is given by the price flexibility of demand which is derived below.

The standard formula for the elasticity of demand is :

$$\text{Elasticity} = \frac{\Delta Q}{\Delta P} \times \frac{P}{Q} \qquad (1)$$

However, it was stated earlier that the price flexibility of demand is in fact the inverse of the elasticity of demand, so it therefore is represented by the formula :

$$\text{Flexibility} = \frac{\Delta P}{\Delta Q} \times \frac{Q}{P} \qquad (2)$$

The partial demand curve is represented by the model :

$$P = \alpha + \beta Q \qquad (3)$$

Differentiating P with respect to Q gives :

$$\frac{\Delta P}{\Delta Q} = \beta \qquad (4)$$

DOVER SOLE **TABLE 3**

Dependent Variable = Price of Dover Sole

Substitute Variable = Price of Monkfish

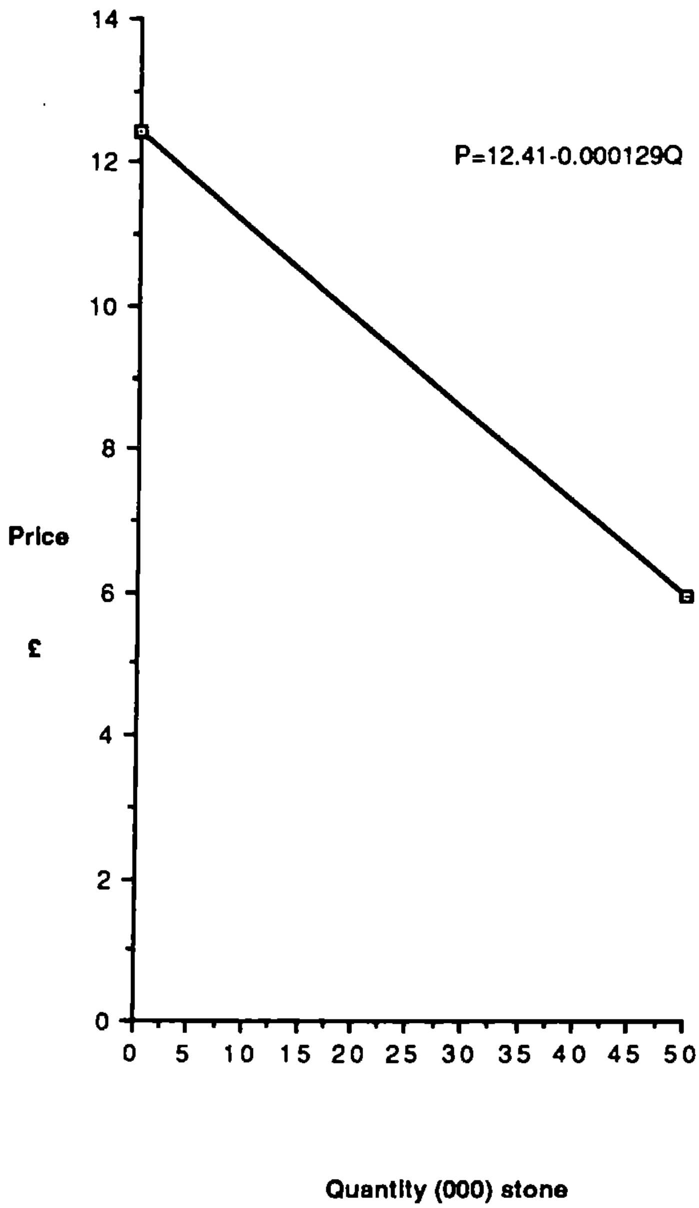
Model	α	Q_{DS}	P_{MO}	T	F	M	A	M	J	J	A	S	O	N	D
Co-efficients	12.41	-0.000129	0.388	-0.024	1.32	1.14	-1.01	0.02	3.83	5.08	2.63	4.20	2.63	2.59	4.71
* t Statistics	* 7.11	-1.68	* 2.32	-1.18	0.95	0.87	-0.78	0.02	* 2.90	* 3.91	2.01	* 3.04	* 2.04	1.91	* 3.48

Summary Statistics **R^2 = 50.4% DW = 2.14 F = 5.22* R^2 = 62.4%

* Significant at the 0.05% level ** R^2 adjusted for degrees of freedom.

Figure 1

Dover Sole - Partial Flexibility Function



Substituting equation (3) for P into equation (2) gives :

$$\text{Flexibility} = \frac{\beta Q}{\alpha + \beta Q} \qquad (5)$$

As can be seen from equation (5), the price flexibility of demand does not remain constant along a linear demand curve. For small quantities, the point price flexibility is small, and at larger quantities it increases as depicted below in Table 4.

Quantity	Point Price Flexibility
5,000	0.05
50,000	1.08

TABLE 4 Dover Sole Price Flexibilities

At 5,000 stone, a 1% rise in quantity will cause a 5% of a 1% change in price, for example, if quantity rises 1% from 5,000 stone to 5,050 stone, the price of Dover Sole as given by equation (3) and Table 3 will fall from £11.765p to £11.759p. The price differential is 0.006p which corresponds to a price flexibility of 0.05. The conclusion here is that when quantity is small, changes in that quantity will cause very small changes in price.

For larger quantities, the result of changes in quantity induce larger changes in price. To illustrate, at 50,000 stone, the resultant price of Dover Sole given by equation (3) is £5.96p. A 1% rise in quantity to 50,500 stone will determine a new price of £5.8955p, a difference of 0.0645 pence which corresponds to a price flexibility of 1.08.

Two important conclusions stem from this analysis. Firstly, it is evident from Table 4 that at high quantities a 1% change in quantity induces a more than proportionate change in price. Secondly, between different months if one experienced a large change in quantity from an existing high level of quantity, then the resulting price change will be considerable, although this is conditional upon the assumption of a linear demand curve which produces variable flexibilities. For example, using equation (3) and Table 3, a 20% fall in quantity from 50,000 to 40,000 stone would induce a price rise in Dover Sole from £5.96p to £7.25p per stone, which represents a rise in the unit price of 21.6% [1]. Changes such as this would lead to large increases in the cost of fish to port merchants.

The above discussion is not only dependent upon the linearity assumption, but also that everything else is held constant; an unrealistic proposition when the Dover Sole model comprises many variables.

Of these, the price of Monkfish is found to be a significant substitute with the correct sign, indicating that as the price of Monkfish rises, so will the price of Dover Sole. A clearer picture of the effect of the substitute price can be gained by the derivation of the cross price flexibility of demand, which is given by the formula :

$$\text{Cross Price Flexibility} = \frac{\beta\,Psub}{\alpha + \beta Psub} \qquad (6)$$

---

1. For large changes in quantity such as this, the estimation of the price flexibility of demand by the point method is no longer accurate. Instead, the arc method would need to be used.

As with the price flexibility, the linear relationship between price and substitute price will lead to a range of cross price flexibilities for different substitute prices. A range of these are given below in Table 5 :

Substitute Price (£)	Cross Price Flexibility
1	0.03
10	0.24

TABLE 5 Dover Sole Cross Price Flexibilities

The magnitude and range of this cross price flexibility is quite small, and in relative terms, the substitute price exerts less of an influence upon own price than changes in own quantity. For example, at low values of the substitute price, a 1% change will cause a 0.03% change in the price of Dover Sole. While at higher values of Monkfish, a 1% change in price will cause a 0.24% change in own price. The interesting point to note here is that for realistic substitute price ranges, at no time does the change in own price become proportionately more than the change in the substitute price.

The third variable in the Dover Sole model is a time trend included to act as a global demand shifter throughout the estimation period. Although this variable is not statistically significant, it has a negative sign indicating that demand has fallen over the estimation period. This is somewhat surprising considering that Dover Sole is considered by many merchants to be the most important and desirable species. One possible reason for the sign of the time trend is depicted graphically below :

Figure 2 Time Series of Dover Sole Price

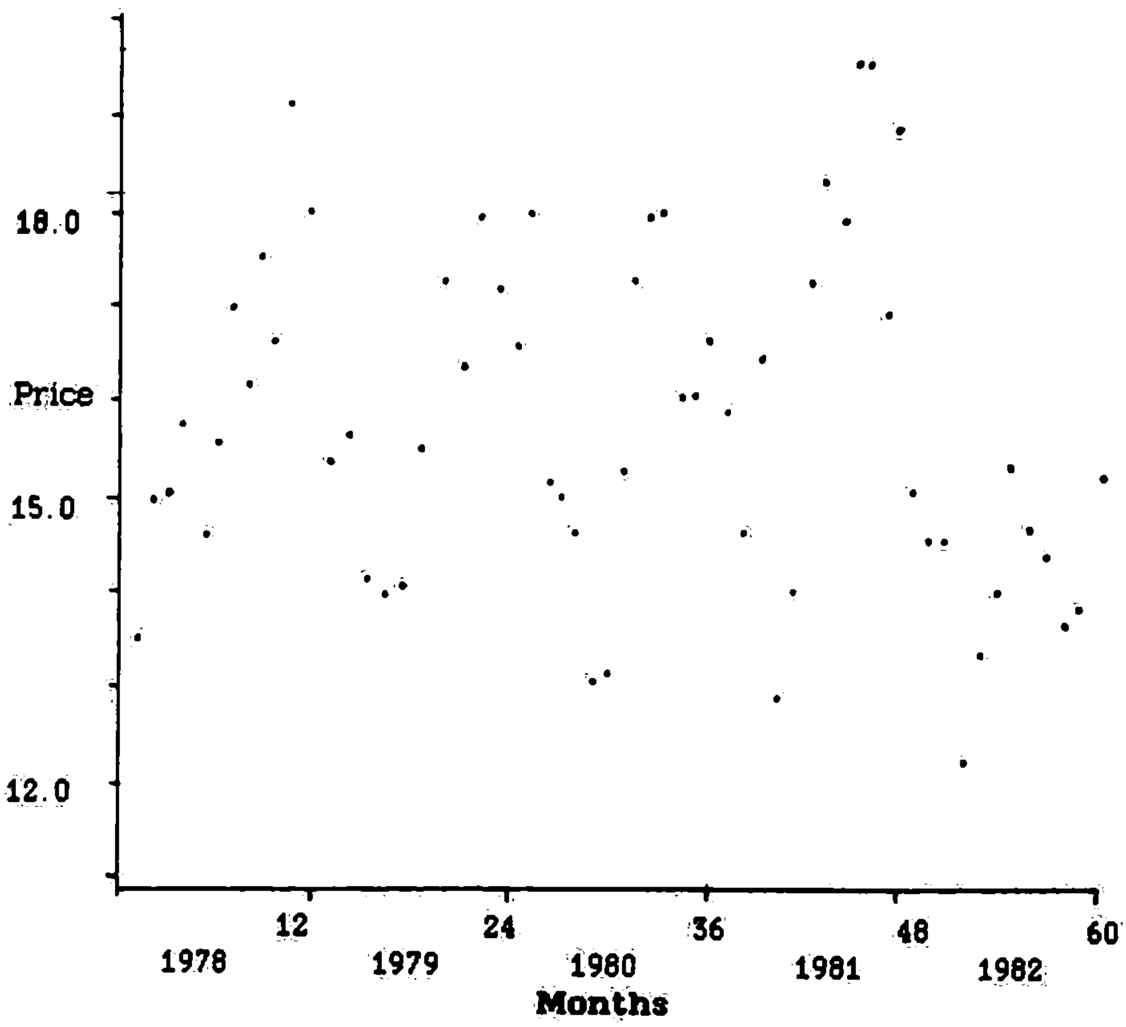


Figure 2 is a time series plot of the price of Dover Sole for each month over the estimation period. Apart from showing the seasonality in the data, the graph shows that up until the end of 1981 the price of Dover Sole was relatively stable and showing a slight upward trend.

However, in 1982 it can be seen that the real price slumped quite dramatically. It is highly probable that this is responsible for the negative sign on the time trend. It is also clear that in 1982, something dramatically affected the demand for Dover Sole as measured by price, and that something is not included in the model. Clearly the model which has the ability to forecast accurately must account for such movements. This problem is returned to in the next section.

The seasonal variation in the price of Dover Sole forecast by the model is shown graphically in Figure 3.[2] As can be seen the extent of price variation is extensive with two broad seasons; a low price in the first five months of the year and higher prices for the remainder of the year. These seasonal variations are a combination of supply and demand effects. The fact that five of the eleven seasonal variables are statistically significant reinforces the hypothesis of seasonality.

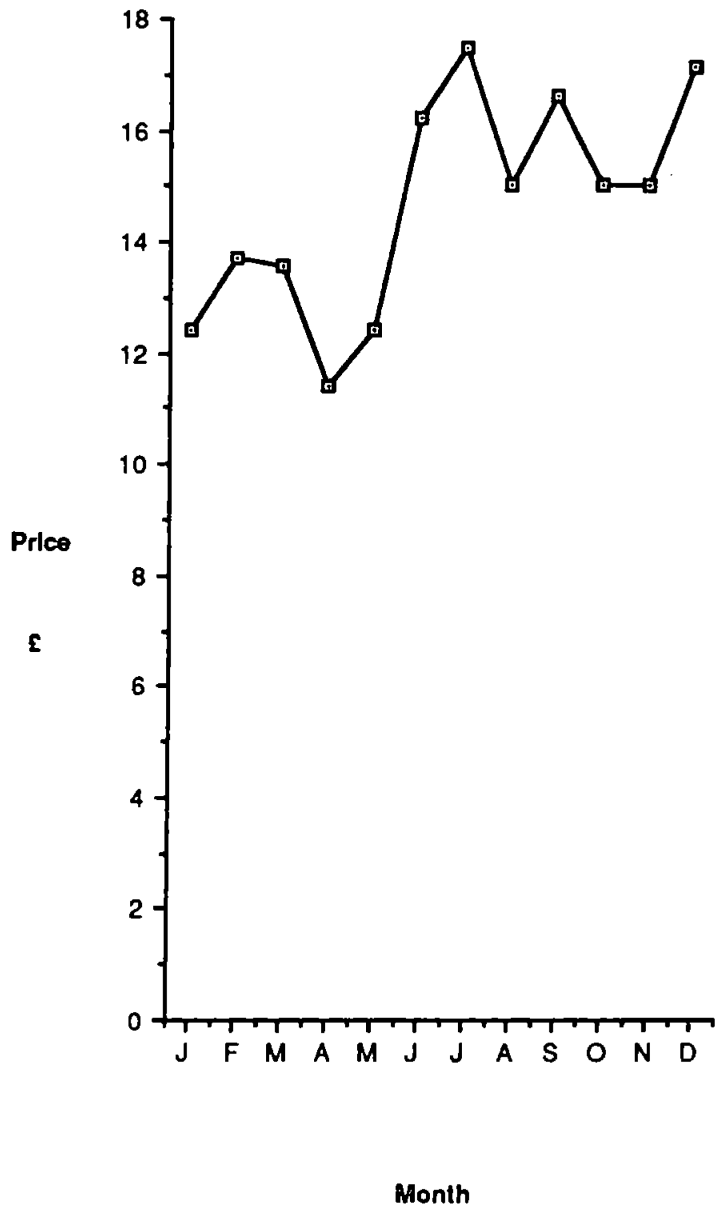
The overall performance of the model can only be called satisfactory; the hypothesised set of independent variables explaining half of the total variation in the dependent variable indicating that important variables affecting the price of Dover Sole have been omitted from the estimating equation. Having said this though, the whole equation is statistically significant as measured by the F statistic.

---

2. This seasonal pattern in price is obtained by adding or subtracting the monthly co-efficient to the January intercept, allowing one to see the magnitude of seasonal variation in price above.

Figure 3

Seasonal variation in Price - Dover Sole



The problem of omitted variables, particularly from a forecasting point of view, has been referred to above. However, a consideration of the off diagonal elements of the correlation matrix for the Dover Sole model revealed the presence of multicollinearity between the quantity of Dover Sole and the time trend. This is not altogether surprising given that quantity has risen over the estimation period and is, therefore, likely to be correlated with time. Multicollinearity in this instance may well be responsible for the insignificant t statistic for own quantity. The temptation to remedy the problem by omitting one of the two variables, preferably time, has to be resisted for the reason that trends between the two variables are likely to exist in the future and both variables are likely to be important in forecasting the price of Dover Sole in the future and should be retained. In addition, the parameter estimates remain unbiased.

7.1.2 Monkfish

The results from the Monkfish model are presented overleaf in Table 6.

The relationship between price and own quantity has the expected sign and is highly statistically significant. The price flexibilities derived as before are shown below :

Quantity	**Price Flexibility**
5,000	0.21
25,000	5.73

TABLE 7 Monkfish Price Flexibilities

The range of quantities in Table 7 only runs to 25,000 stones, for at higher levels of quantity, the equation forecasts negative prices owing to the partial nature of the model in this context. However, one can see that the estimated range of the price flexibility is quite large. A 1% change in quantity at high levels of quantity would induce more than proportionate changes in price in the order of 5.73%. In reality, the monthly landings of Monkfish (as well as other species) lie in the range 0 - 15,000 stone, therefore the proportionate change in price will not be so large. Nevertheless, this model does show that the price of Monkfish is relatively sensitive to changes in own quantity.

The substitute price, Dover Sole, has the correct sign and is statistically significant. The resulting cross price flexibilities for a realistic range of substitute prices are shown on Page 153 in Table 8.

MONKFISH **TABLE 6**

Dependent Variable = Price of Monkfish

Substitute Variable = Price of Dover Sole

Model	α	Q_{mo}	P_{DS}	T	F	M	A	M	J	J	A	S	O	N	D
Co-efficients	4.61	-0.000157	0.205	0.0643	-1.87	0.36	0.66	0.43	-0.70	-0.74	0.06	-0.10	0.35	-0.53	-1.44
* **t Statistics**	* 3.02	* -4.99	* 2.15	* 4.71	* -2.07	0.40	0.74	0.48	-0.71	-0.72	0.07	-0.09	0.38	-0.56	-1.4[illegible]

Summary Statistics **R^2 = 38.6% DW = 2.19 F = 3.61* R^2 = 53.6%

* Significant at the 0.05% level ** R^2 adjusted for degrees of freedom.

Price of Substitute (£)	Cross Price Flexibility
1	0.04
10	0.31
20	0.47

TABLE 8 Monkfish Cross Price Flexibilities

As with the Dover Sole model, the cross price flexibilities for Monkfish are considerably lower than the price flexibilities. A 1% change in the substitute price induces relatively small changes in price.

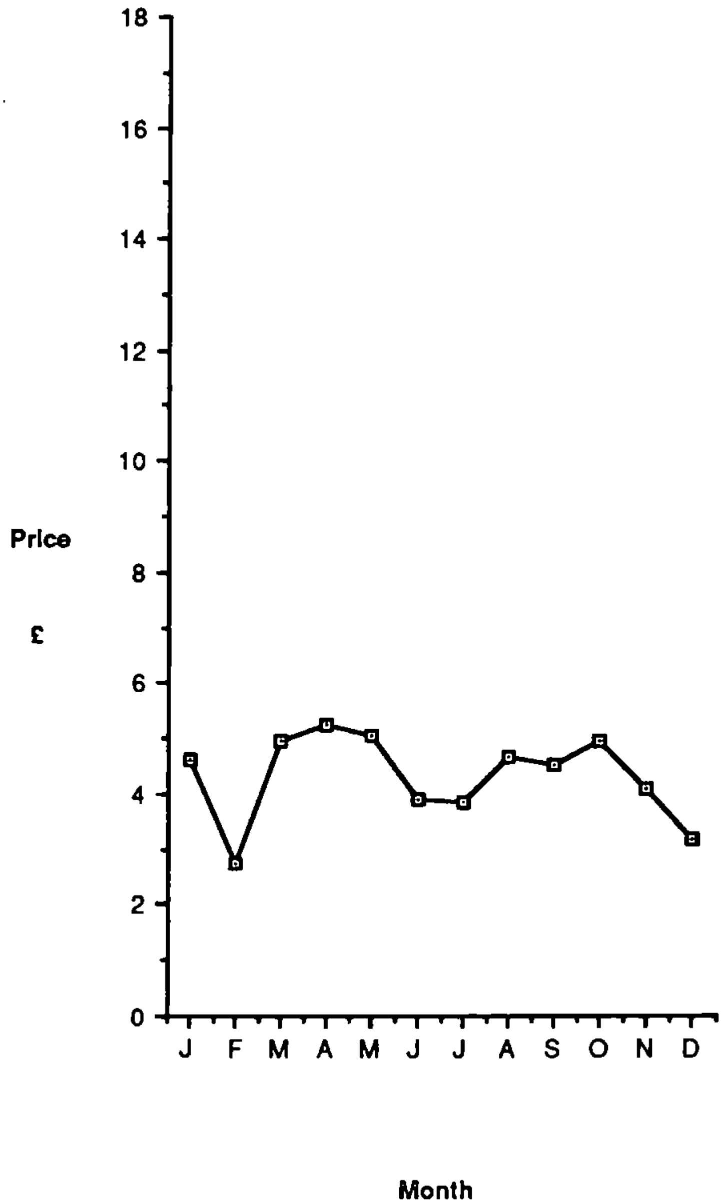
The time trend in the Monkfish model has a positive sign and is highly significant. This tends to confirm what was said about the demand for Monkfish having risen over recent years at South West ports as a result of increased demand from the Continent for this species.

The dummy variables included to represent seasonal variation in price do not appear particularly important, either in terms of absolute magnitude or statistical significance. In fact the only significant seasonal variable is that for February. From the diagram in Figure 4, it is difficult to discern any marked season; with the exceptions of February, June, July and December, price remains very much the same when determined by seasonal variables alone.

It is perhaps the lack of significance in the seasonal variables which contributes to the relatively poor overall performance of the model. Just under 40% of the total variation in the price of Monkfish is explained by the model, The whole equation is only just significant as denoted by the F statistic. The suggestion from

Figure 4

Seasonal variation in Price - Monkfish



this is that there are important explanatory variables which are not present in the model. One possible implication of this is that while the slope parameters remain unbiased, the original intercept parameter is in fact a biased estimate, likely to cause spurious forecasts if the model is used in its present form.

As with the Dover Sole model, multicollinearity was detected in the Monkfish model between quantity and the time trend. However, for reasons outlined above, it was decided to keep both variables in the model.

Another potential problem can be detected from the magnitude of the range of the own price flexibility. In the Monkfish model, price is made up of fourteen explanatory variables; however, the partial relationship between price and quantity appears rather sharp. Once quantity rises over 25,000 stones, the partial demand curve forecasts prices which are negative. While remembering that this is a partial relationship, it does seem strange that negative prices are forecast. The possible reason for this may lie in a general mis-specification of the model. The demand curve may be curvilinear rather than linear. An alternative specification designed to test this assumption is presented later in the chapter.

7.1.3 Lemon Sole

The results from the Lemon Sole model are presented overleaf in Table 9.

As with the previous models, the own quantity coefficient has the expected negative sign, and is statistically significant. Table 10 below shows the price flexibilities of demand for a range of quantities.

Quantity (St)	Point Price Flexibility
5,000	0.13
20,000	2.43
40,000	17.00

TABLE 10 Lemon Sole Price Flexibilities

The range of flexibilities obtained for Lemon Sole vary quite dramatically. At low quantities, a 1% change in quantity induces a 0.13% change in price. At very high quantities, a 1% change in quantity induces at 17.00% change in price showing price to be very flexible indeed. One must remember though, that this is purely illustrative as quantity rarely reaches these high levels. In addition, the very high flexibilities at the top of the quantity range lead one to question the linearity assumption behind the model, as in the last section.

The substitute variable, the price of Plaice, has the correct sign, but is not significant at the 95% level. The resulting cross price flexibilities are shown below for a range of substitute prices:

LEMON SOLE **TABLE 9**

Dependent Variable = Price of Dover Sole

Substitute Variable = Price of Monkfish

Model	α	Q_{LS}	P_{PL}	T	F	M	A	M	J	J	A	S	O	N	D
Co-efficients	5.21	-0.000123	0.426	0.0195	1.30	0.78	-1.07	-1.91	-0.87	-1.46	-0.0004	-0.81	1.28	0.03	1.47
* t Statistics	* 4.52	* -2.45	1.72	1.93	1.56	-1.08	-1.53	* -2.18	-1.09	-1.76	-0.00	-0.89	1.40	0.03	1.56

Summary Statistics **R^2 = 61.6% DW = 1.86 F = 7.65* R^2 = 70.9%

* Significant at the 0.05% level ** R^2 adjusted for degrees of freedom.

Substitute Price (3)	Cross Price Flexibility
1	0.08
5	0.29
10	0.45

TABLE 11 Lemon Sole Cross Price Flexibilities

As can be seen from Table 11, the percentage change in own price as a result of a 1% charge in the substitute price is not great. The range of the cross price flexibility is quite narrow also.

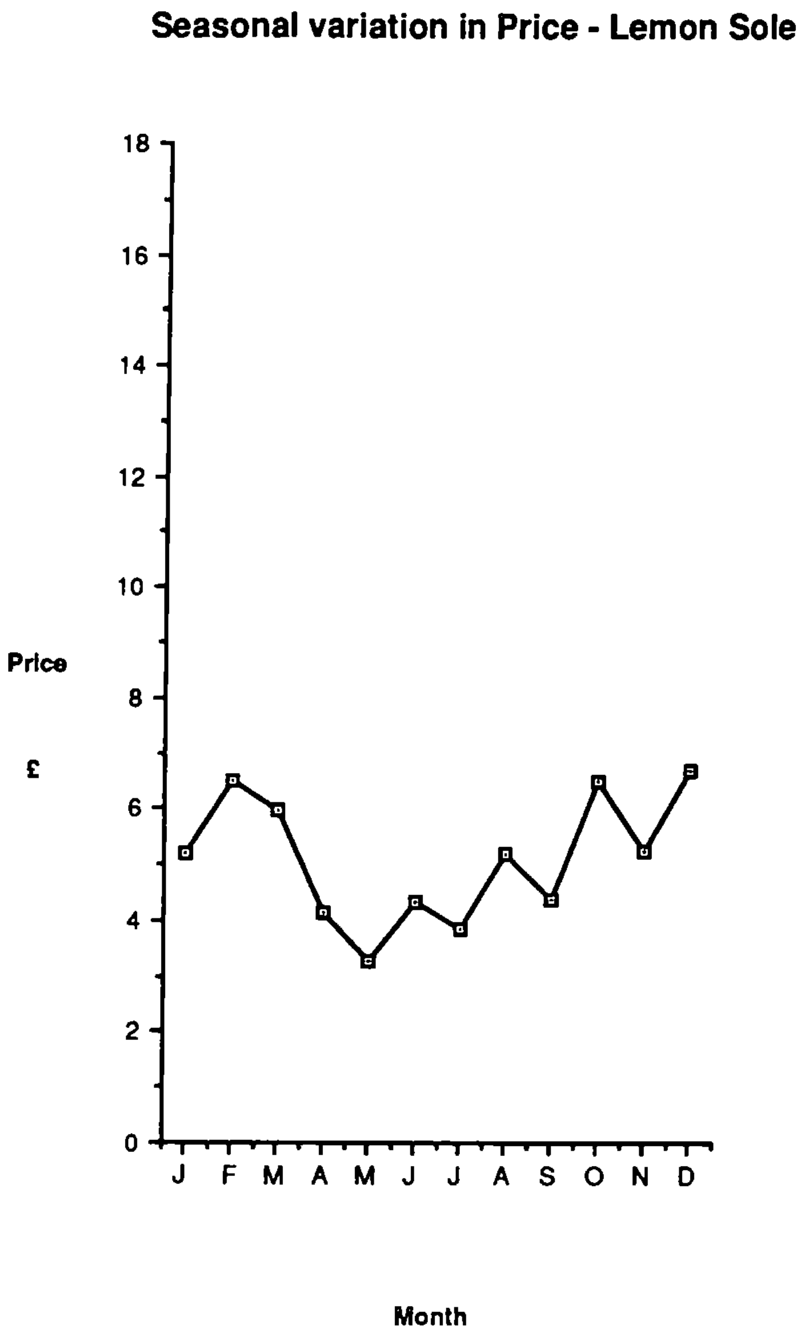
The time trend in the Lemon Sole model is indicative of an upward trend in demand over the estimation period, although the time trend is not statistically significant.

The fact that only one seasonal variable, May, is statistically significant belies the fact that in terms of absolute magnitude, several of the seasonal variables appear large. The seasonal pattern shown in Figure 5 shows the seasonal variation with price being low in the months April to July and higher in the remaining months.

The overall performance of the model is better than the preceding two, with over 60% of the variation in the price of Lemon Sole explained by the set of independent variables. In addition, the equation as a whole is highly significant.

This does not mean to say that the model is without its problems. The linearity assumption has already been questioned. In addition, Multicollinearity was detected between the quantity of Lemon Sole and the price of Plaice, although the quantity variable remains significant.

Figure 5



Seasonal variation in Price - Lemon Sole
18
16
14
12
10
8
6
4
2
0
Price
£
J F M A M J J A S O N D
Month

7.1.4 Plaice

The results from the Plaice model are presented overleaf in Table 12.

The relationship between price and quantity is of the correct sign and significant. The range of point price flexibilities are shown below :

Quantity	Point Price Flexibility
5,000	0.15
20,000	1.10
35,000	11.23

TABLE 13 Plaice Price Flexibilities

Again one can see that at small quantities, a 1% change in quantity leads to small changes in price. The price flexibility grows steadily with increasing quantity until one reaches very high quantities when it becomes very large.

It is found that the price of Lemon Sole as a substitute is a significant determinant of the price of Plaice, with the following cross price flexibilities below;

Substitute Price	Cross Price Flexibilities
1	0.06
5	0.24
10	0.38

TABLE 14 Plaice Cross Price Flexibilities

PLAICE

TABLE 12

Dependent Variable = Price of Plaice

Substitute Variable = Price of Lemon Sole

Model	α	Q_{PL}	P_{LS}	T	F	M	A	M	J	J	A	S	O	N	D
Co-efficients	2.63	-0.000069	0.164	-0.0084	-1.24	-0.39	0.007	0.82	0.82	1.43	0.97	1.12	0.53	1.38	0.77
* **t Statistics**	* 5.37	* -2.97	* 2.24	-1.53	* -3.69	-1.22	* 0.02	* 2.59	* 2.46	* 4.31	* 3.02	* 3.57	1.48	* 3.91	1.97

Summary Statistics **R^2 = 80.2% DW = 2.05 F = 17.81* R^2 = 85.0%

* Significant at the 0.05% level ** R^2 adjusted for degrees of freedom.

As with all the models discussed thus far, a 1% change in the subsitute price induces relatively small changes in own price.

The time trend indicates that demand as measured by own price has been falling over the estimation period, although not significantly.

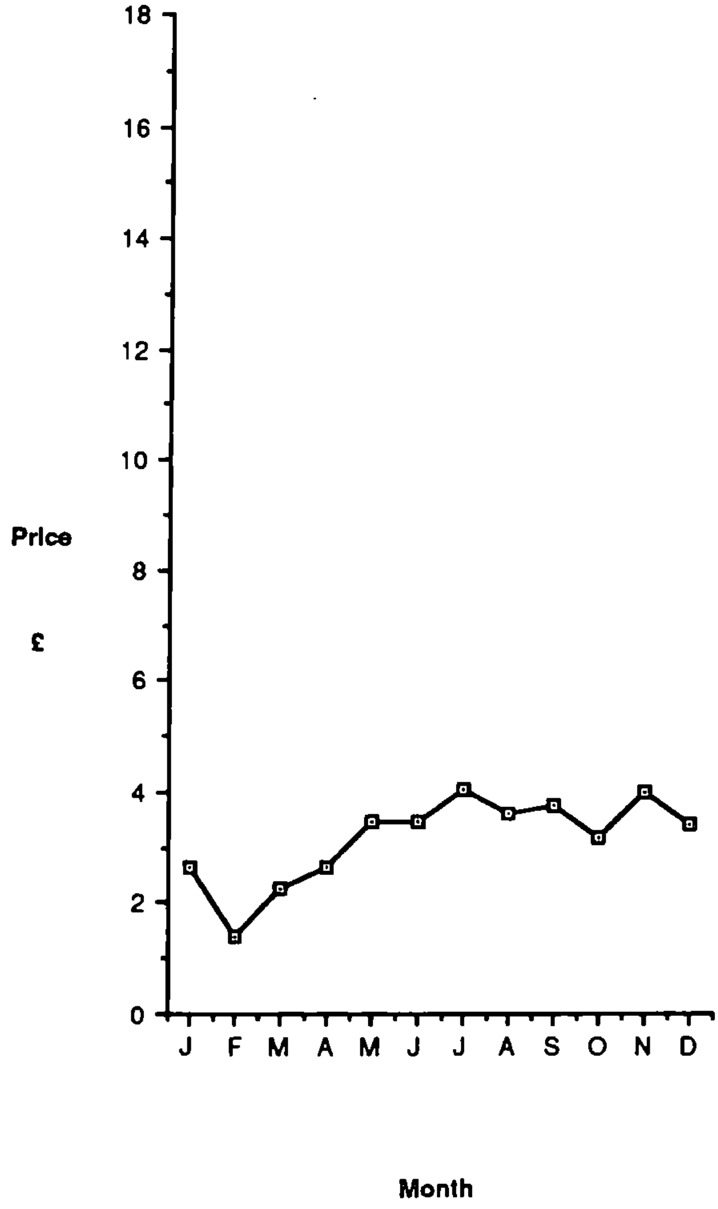
The seasonal variation in the price of Plaice is very marked, with seven out of eleven variables significantly different to January. In fact, apart from April, the price differential for all months in absolute terms differs from January. Figure 6 shows the pattern of seasonal variation; price being low in the first four months of the year and relatively higher for the remainder.

Undoubtedly, this significant seasonal variation contributes to the high degree of explanatory power of the equation, with an R^2 of over 80%. In addition, as one would expect the equation is highly significant.

In common with other models, multicollinearity was detected between quantity and the time trend.

Figure 6

Seasonal variation in Price - Plaice



7.1.5 Hake

It can be seen from Table 15 overleaf that the performance of the Hake model is most unsatisfactory. The only significant variable in the equation is own quantity, but the sign is positive indicating that as quantity increases, own price also increases. The remaining variables in the equation do not appear to enhance any understanding of variation in the dependent variable. The values of R^2 and the F statistic indicate that the specified model is in fact the wrong model entirely.

The reasons for the poor performance of the Hake model are not immediately apparent. One possibility is that the variation in the price of Hake is totally random and that no independent variables are capable of explaining price variation.

There are although, several reasons which in combination may account for this problem situation. One of these may relate to the concept of homogeneity of species. The average monthly price of Hake is an average of many grades. There are up to five grades of Hake offered for auction, the Small Hake bearing little resemblance to the large grade in terms of unit price. It may be that the assumption of an average demand curve for this species breaks down, and that the demand conditions for each grade are so different to invalidate the averaging concept. Without data on each grade, this hypothesis is impossible to test.

It is patently obvious from the Hake model that important variables have been excluded from the equation. In addition, the model perhaps should not have been estimated in a linear form.

HAKE **TABLE 15**

Dependent Variable = Price of Hake

Substitute Variable = Price of Dover Sole

Model	α	Q_{HA}	P_{DS}	T	F	M	A	M	J	J	A	S	O	N	D
Co-efficients	3.25	0.00014	0.291	-0.0067	0.66	2.09	1.10	0.41	-0.06	-0.33	0.95	1.59	1.81	0.40	0.82
* t Statistics	1.54	* 2.48	0.68	-0.39	0.51	1.61	0.80	0.32	-0.04	0.22	0.71	1.08	1.46	0.20	0.56

Summary Statistics R^{2**} = 3.3% DW = 1.67 F = 1.14 R^2 = 26.6%

* Significant at the 0.05% level ** R^2 adjusted for degrees of freedom.

Another possible reason for the almost total failure of the model might be in the nature of the Hake market. In contrast to the other species for which models were estimated, at the beginning of the estimation period, Hake was not an established species at South West ports. It can be seen from Appendix 2 that for the first two years of the estimation period that Hake landings fluctuated wildly but were generally very small. For example, in March 1979 only just over three tons were landed at the three major ports. In fact the maximum monthly landings in these two years was just over 12 tonnes, or approximately 20 stone per day at any one port. It may well be that for this period, a strong relatively constant demand did not develop as the available supplies of Hake were generally small. However, after the beginning of 1980, landings of Hake increased considerably in general and continued to grow throughout the estimation period.

There are several possible implications of this for the single equation model of Hake. Firstly, one might be witnessing a developing market probably in response to the demand from Spain. It may be that demand parameters at the beginning of the estimation period differ substantially from those in the second half of the period with the result that estimation over the whole period produces meaningless parameter estimates.

A more likely implication of the rapidly developing Hake market is that it leads to an identification problem. There are two factors here. Firstly, that demand has shifted about so much as a result of factors not included in the model. If this were the case, then a mongrel of many different demand curves may have been identified leading to the peculiar results. A second possible complicating factor also relates to the nature of fluctuating demand in a developing market. If the development of the Hake market was rapid and demand led, then the assumption of inelastic supply might well be invalid. If this is true, then not only will the model parameters be biased, but from the identification side the problem becomes more complicated. The results in the model might well be a combination of the demand and supply curves rather than just the demand curve.

7.1.6 Demersal

Considering that the demersal model is an aggregate different species, it performs well as a measure of the average demand conditions for all species.

The relationship between price and quantity (Table 16) is highly significant and yet very small. The range of point price flexibilities are shown below in Table 17 :

Quantity	Point Price Flexibility
5,000	0.009
50,000	0.10
100,000	0.22

TABLE 17 Demersal Price Flexibilities

The very small values for the price flexibility are to some extent expected. The demersal group is very aggregated with many species having different demand conditions. For individual species, the presence of close substitutes means that price is quite responsive to changes in quantity. For demersal species as a whole, there are no close substitutes, with the result that the price flexibilities are small.

The time trend, although not statistically significant, shows that demand has grown over time for demersal species.

With so many different individual seasons amalgamated within the model, it is not surprising that the overall seasonal pattern is not particularly striking (see Figure 7). Little seasonal variation occurs until the last four months of the year when price does show significant increases, possibly the result of supply side variations at that time of the year.

DEMERSAL **TABLE 16**

Dependent Variable = Price of Demersal

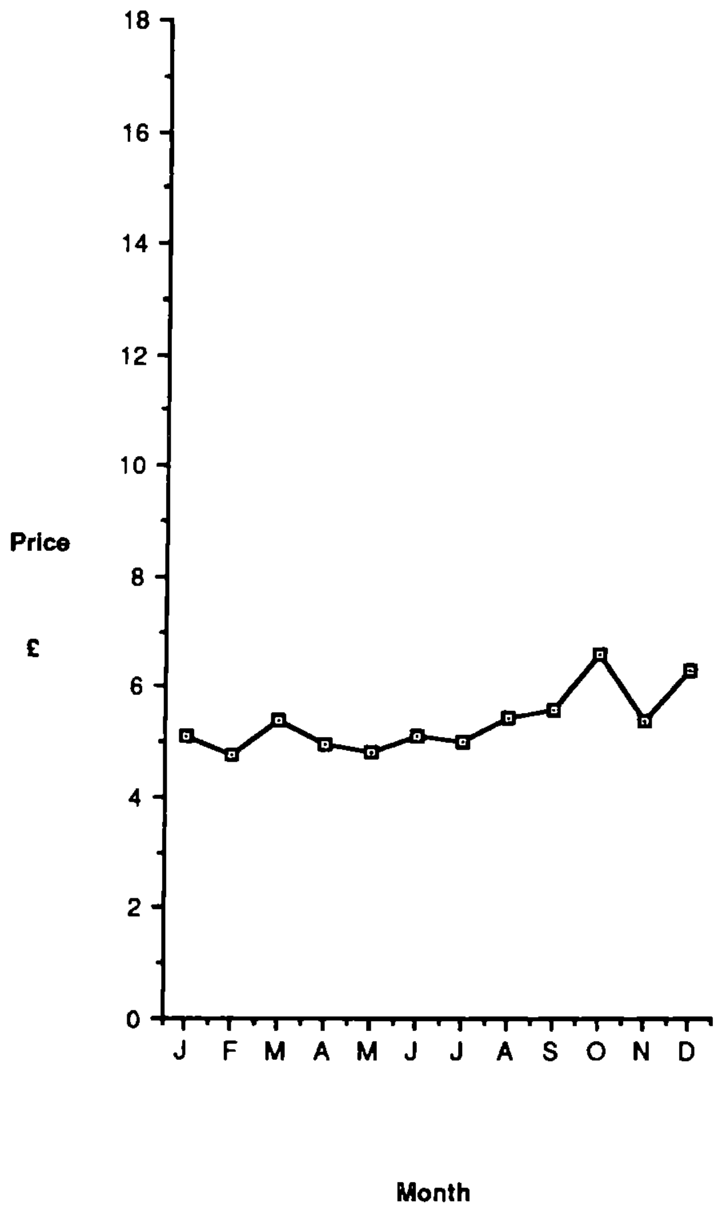
Model	α	$\log_e Q_{DEM}$	T	F	M	A	M	J	J	A	S	O	N	D
Co-efficients	5.09	-0.000009	0.011	-0.31	0.29	-0.13	-0.26	0.02	-0.09	0.36	0.49	1.49	0.31	1.20
* t Statistics	* 14.52	* -4.17	1.89	-0.82	0.76	-0.35	-0.67	0.04	-0.24	0.96	1.30	* 3.86	0.79	* 3.00

Summary Statistics ** R^2 = 61.4% DW = 1.91 F = 8.11* R^2 = 70.1%

* Significant at the 0.05% level ** adjusted for degrees of freedom.

Figure 7

Seasonal variation in Price - Demersal



In overall terms, the equation is significant, explaining over 60% of the variation in the demersal price.

7.2 Problems

The single equation models presented in the previous section have all been estimated with varying degrees of success. The Lemon Sole, Plaice and Demersal models appear to have performed satisfactorily, justifying the single equation specification. Some problems exist with Dover Sole and Monkfish, while the single equation specification for Hake seems to have been wholly inappropriate. Clearly, these problems should be considered, and the models re-examined in their light.

Some of the problems are model specific and were identified in the last section relating mainly to functional form and omitted variables. A more general set of problems exists, of which one relates to the use of price as a substitute variable. The crucial assumption here is that price is an exogenous variable and independent of the error term. However, substitute price cannot be truly independent as it is also determined by quantity in another model. The central point is that substitute price has to be independent of the demand for that species for which it acts as a substitute; if it is not, then simultaneous equation bias may be expected. In a market situation, such as that for demersal fish, where quantity is fixed in the short term, it is doubtful that prices can be truly regarded as exogenous owing to the interdependency that exists. In general, visual plots of the residuals against the substitute price for each model did not reveal any significant relationships though.

However, the problem does not stop here. In the Dover Sole, Monkfish, Lemon Sole and Plaice models, substitute price cannot be regarded as independent of the demand for that species for which it is a substitute. For example, in the Dover Sole model, the price of Monkfish acts as a substitute. If the price of Monkfish was not affected by the demand for Dover Sole, then no problem would exist, but unfortunately, it does. The reason is that in the Monkfish model, the price of Dover Sole acts as a substitute. Not only does the price of Monkfish determine the price of Dover Sole, but the price of Dover Sole helps to determine the price of Monkfish. Whilst checks of the residuals did not reveal a problem it intuitively seems that a specification error is present. Two solutions to this problem are contained in the next section. One in which subsitute price is replaced by substitute quantity to act as an instrumental variable which can be regarded as independent due to the inelastic supply assumption. Secondly, a simultaneous specification which allows prices to be determined interdependently.

Obviously, one could postulate many different specifications of models of demand, partly to improve upon existing models and also purely as alternative models. If the estimated models are to be used successfully for forecasting, then it is desirable that alternative specifications are tested partly to improve their explanatory power, and also as alternative representations of the market for demersal fish.

7.3 Alternative Specifications

Having questioned the validity of using price as the substitute variable, the four models with interactive substitutes were re-estimated with the corresponding quantity as the substitute. The results are shown overleaf in Tables 18 - 21.[3]

The results of this alternative are mixed. Using quantity as the substitute instead of price, one would expect a negative relationship between price and substitute quantity, indicating that as substitute quantity fell, buyers would increase demand for the other species thus raising price. However, with the exception of Dover Sole, substitute quantity does not have the anticipated sign. With the exception of the Plaice substitute in the Lemon Sole model, none is statistically significant. The reasoning behind the positive sign on the majority of substitute variables is not immediately apparent. One possible reason may be that quantity is not a good proxy substitute variable and that price really should be used to explain substitution effects as conventionally suggested by economic theory. Another possiblity is indicated from the Lemon Sole model. The quantity of Plaice is both positive and significant, and in comparison with the corresponding price substitute model, the time trend has changed from positive to negative. Quite possibly, the quantity variable (which has grown over time in common with most species) has taken over the role of the time trend and is explaining upward trends in price. While this may be the case for Lemon Sole, in all the other models, the results are very similar to those estimated with substitute price. In general, most equations are slightly less significant than the price substitute models leading to the conclusion that the models do not appear to have been improved in any way.

---

3. All models have been subjected to the generalised differing procedure to account for autocorrelation described at the outset of this chapter.

<u>**DOVER SOLE**</u> <u>**TABLE [illegible]**</u>

Dependent Variable = Price of Dover Sole

Substitute Variable = Quantity of Monkfish

Model	α	Q_{DS}	Q_{MO}	T	F	M	A	M	J	J	A	S	O	N	D
Co-efficients	15.15	-0.000118	-0.000021	-0.0127	0.89	1.52	-0.96	0.39	3.62	5.21	2.85	4.62	2.91	2.84	4.6[illegible]
* **t Statistics**	* 11.24	-1.37	-0.41	-0.58	0.61	1.12	-0.70	0.26	* 2.53	* 3.83	* 2.06	* 3.19	* 2.16	2.01	* 3.30

Summary Statistics $^{**}R^2$ = 44.6% DW = 2.04 F = 4.34* R^2 = 58.0% $\hat{p}$ = 0.4859

* Significant at the 95% level ** adjusted for degrees of freedom.

MONKFISH **TABLE 19**

Dependent Variable = Price of Monkfish

Substitute Variable = Quantity of Dover Sole

Model	α	Q_{mo}	Q_{DS}	T	F	M	A	M	J	J	A	S	O	N	D
Co-efficients	6.65	−0.000183	0.000095	0.0505	−0.92	0.85	0.66	1.50	0.61	0.59	1.06	1.57	0.94	0.60	0.14
* t Statistics	7.36	−5.45	1.69	3.48	−0.97	0.95	0.74	1.51	0.65	0.67	1.17	1.67	1.07	0.65	0.15

Summary Statistics **R^2 = 36.2% DW = 1.87 F = 3.35* R^2 = 51.6% $\hat{p}$ = 0.4804

* Significant at the 95% level ** adjusted for degrees of freedom.

LEMON SOLE **TABLE 20**

Dependent Variable = Price of Lemon Sole

Substitute Variable = Quantity of Plaice

Model	α	Q_{LS}	Q_{PL}	T	F	M	A	M	J	J	A	S	O	N	D
Co-efficients	6.81	-0.000172	0.00029	-0.00125	-0.078	0.42	-1.60	-1.90	-1.31	-1.53	0.07	-0.53	0.94	0.97	2.34
* **t Statistics**	* 8.60	* -3.27	* 2.03	-0.11	-0.10	0.56	* -2.17	* -2.15	-1.48	-1.80	0.08	-0.60	0.97	1.07	* 2.68

Summary Statistics $^{**}R^2 = 62.2\%$ DW = 1.83 F = 7.83* $R^2 = 71.4\%$ $\hat{p} = 0.5137$

* Significant at the 95% level ** adjusted for degrees of freedom.

PLAICE **TABLE 21**

Dependent Variable = Price of Plaice

Substitute Variable = Quantity of Lemon Sole

Model	α	Q_{PL}	Q_{LS}	T	F	M	A	M	J	J	A	S	O	N	D
Co-efficients	3.66	-0.000067	0.000006	-0.009	-1.09	-0.43	-0.34	0.49	0.61	1.14	0.99	1.09	0.82	1.52	1.16
*	*	*			*					*	*	*	*	*	*
t Statistics	11.11	-2.60	0.20	-1.63	-3.32	-1.40	-1.09	1.43	1.69	3.21	2.78	3.04	2.03	4.01	3.15

Summary Statistics **R^2 = 79.7% DW = 2.07 F = 17.3* R^2 = 84.6% $\hat{p}$ = 0.3286

* Significant at the 95% level ** adjusted for degrees of freedom.

An alternative way of tackling the price substitute problem was to postulate the following simultaneous models for Dover Sole and Monkfish, and Lemon Sole and Plaice respectively.

$$P_{ds} = \alpha_{11} + \beta_{12} Q_{ds} + \beta_{13} P_{mo} + \beta_{14}t + \beta_{15}D - \beta_{115}D + e_1 \qquad (1)$$

$$P_{mo} = \alpha_{12} + \beta_{22} Q_{mo} + \beta_{23}P_{ds} + \beta_{24}t + \beta_{25}D - \beta_{215}D + e_2 \qquad (2)$$

where :

P_{ds}	=	Price of Dover Sole
Q_{ds}	=	Quantity of Dover Sole
P_{mo}	=	Price of Monkfish
Q_{mo}	=	Quantity of Monkfish
t	=	Time trend
D	=	Dummy variables

In order to estimate the above model, the reduced form is derived by substituting equation (2) for P_{mo} in equation (1), and equation (1) into equation (2) for P_{ds} :

$$\begin{aligned} P_{ds}(1-\beta_{13}\beta_{23}) = {} & \alpha_{11} + \beta_{13}\alpha_{21} + \beta_{12} Q_{ds} + (\beta_{13}\beta_{22}) Q_{mo} + \\ & (\beta_{14} + \beta_{13}\beta_{24})t + (\beta_{15} + \beta_{25}\beta_{13}) D - (\beta_{115} + \beta_{215}\beta_{13}) D \\ & + \text{an error term} \qquad (3) \end{aligned}$$

$$\begin{aligned} P_{mo}(1-\beta_{23}\beta_{13}) = {} & \alpha_{21} + \beta_{23}\alpha_{11} + \beta_{22} Q_{mo} + (\beta_{23}\beta_{12}) Q_{ds} + \\ & (\beta_{24} + \beta_{23}\beta_{14})t + (\beta_{25} + \beta_{23}\beta_{15}) D - (\beta_{215} + \beta_{23}\beta_{115})D \\ & + \text{an error term} \qquad (4) \end{aligned}$$

which equals :

$$P_{ds} = \frac{\alpha_{11} + \beta_{13}\alpha_{21}}{(1-\beta_{13}\beta_{23})} + \frac{\beta_{21} Q_{ds}}{(1-\beta_{13}\beta_{23})} + \frac{(\beta_{13}\beta_{22})Q_{mo}}{(1-\beta_{13}\beta_{23})} + \frac{(\beta_{14} + \beta_{13}\beta_{24})t}{(1-\beta_{13}\beta_{23})}$$

$$+ \frac{(\beta_{15} + \beta_{25}\beta_{13})D}{(1-\beta_{13}\beta_{23})} \ldots\ldots \frac{(\beta_{115} + \beta_{215}\beta_{13})D}{(1-\beta_{13}\beta_{23})} + \text{an error term} \qquad (5)$$

$$P_{mo} = \frac{\alpha_{21} + \beta_{23}\alpha_{11}}{(1-\beta_{23}\beta_{13})} + \frac{\beta_{22} Q_{mo}}{(1-\beta_{23}\beta_{13})} + \frac{(\beta_{23}\beta_{12}) Q_{ds}}{(1-\beta_{23}\beta_{13})} + \frac{(\beta_{24} + \beta_{23}\beta_{14})t}{(1-\beta_{23}\beta_{13})}$$

$$+ \frac{(\beta_{24} + \beta_{23}\beta_{14})D}{(1-\beta_{23}\beta_{13})} + \ldots\ldots \frac{(P_{215} + \beta_{23}\beta_{115})D}{(1-\beta_{23}\beta_{13})} + \text{an error term} \qquad (6)$$

which can be represented :

$$P_{ds} = \Pi_{11} + \Pi_{12} Q_{ds} + \Pi_{13} Q_{mo} + \Pi_{14} t + \Pi_{15} D - \Pi_{116} D + V_1 \qquad (7)$$

$$P_{mo} = \Pi_{21} + \Pi_{22} Q_{mo} + \Pi_{23} Q_{ds} + \Pi_{24} t + \Pi_{25} D \ldots \Pi_{216} D + V_2 \qquad (8)$$

where :

$$\Pi_{11} = \frac{\alpha_{11} + \beta_{13}\alpha_{21}}{(1 - \beta_{13}\beta_{23})} \qquad \text{etc}$$

$$\Pi_{12}Q_{ds} = \frac{\beta_{12}Q_{ds}}{(1 - \beta_{13}\beta_{23})} \qquad \text{etc}$$

The above model specification was estimated by the Indirect Least Squares method for Dover Sole and Monkfish, and Lemon Sole and Plaice. From the reduced form equation, one can derive estimates of the structural coefficients. This produced the following estimates for the substitute price variable in each equation :

Dependent Variable	**Substitute**	**Coefficient**
Dover Sole	Monkfish	0.6705
Monkfish	Dover Sole	0.3871
Lemon Sole	Plaice	-0.6154
Plaice	Lemon Sole	-0.1145

TABLE 22 Simultaneous Substitute Price Co-efficients

The results from the Dover Sole and Monkfish models appear plausible if not rather on the high side. The results from the Lemon Sole and Plaice models are not of the expected sign. The reason for this is that the estimated structural coefficients are dependent on the sign of substitute quantity in the reduced form equations (7) and (8). In the latter model, the sign was positive producing negative estimates of the substitute price structural coefficients. It is evident from Table 22 that this particular simultaneous specification produces estimates of the substitute price which appear less plausible than those in the single equation specification.

Another class of estimated experiments was attempted to reflect the assumption in the single equation models that changes in the dependent variable are purely the result of changes in the explanatory variables confined to the current time period. When dealing with short time periods such as months, it is quite possible that the previous months quantity will exert an influence upon the current value of price reflecting the idea that one cannot neatly divide a variable's explanatory power into one time period. For this reason, a class of models were estimated with quantity lagged one month as an additional independent variable. In all cases, though, this extra variable was statistically insignificant and did not increase the explanatory power of the models.

An equally valid hypothesis also involving lags refers to the situation where the dependent variable is in fact influenced by the dependent variable in the previous time period. The lagged value of price was not included in the single equation models due to the fact that it introduces bias into the equation through being correlated with the disturbance (See Kennedy P, 1979). However, an approximate idea of the importance of the lagged dependent variable was obtained from the model :

$$P_t = \alpha + \beta_1 P_{t-1} + \beta_2 P_{t-2} + U_t$$

The results are presented in Table 23.

Pt	Pt - 1	Pt - 2
Lemon Sole	0.700 *	-0.068
Plaice	0.928 *	-0.258
Hake	0.445 *	-0.200
Dover Sole	0.607 *	0.040
Monkfish	0.477 *	0.520

* significant at the 95% level

TABLE 23 Lagged Own Price Co-efficients

While these estimates are inaccurate and do not have much meaning in the above context, they do serve to show that as one would expect the lagged value of price has some importance in determining the current value. A more detailed investigation of these autoregressive schema would perhaps be more appropriately conducted through a time series modelling approach rather than explanatory econometrics.

Reverting back to the single equation specification, the three models which need improving are the Dover Sole, Monkfish and Hake models. Owing to the fact that all three are primarily export species, attempts to improve the explanatory power of these models centered around the identification of international factors which might have an effect.

Time series of the monthly Spanish and French exchange rates were tested to determine whether they exerted any effect upon the price of these export species. In all cases, the exchange rate acted very like a time trend and was statistically insignificant. For Monkfish, it was extremely hard to obtain any data which appeared relevant to the model. In the case of Hake, a simultaneous specification which included lagged price in the supply equation was attempted. The results from this model were generally insignificant and confusing.

Considerably more success was had with the Dover Sole model. A consideration of several publications (e.g. O.E.C.D., 1984) led to the identification of the possible reason for the apparent slump in demand for Dover Sole which occurred in 1982. A consideration of Table 24 below shows the changing volume of landings of Dover Sole for several European countries from 1981 to 1982 :

Country	1981	1982	(tonnes)
Netherlands	9,500	16,000	
France	4,960	4,737	
Belgium	3,605	3,892	
South West	810	1,073	

TABLE 24 **European Landings of Dover Sole** (OECD 1984)

The volume of landings remained relatively stable, except for the Netherlands, where the particularly good 1979 year class of Sole led to much increased landings (O.E.C.D. 1982). The significance of these increased Dutch landings of Sole does not begin to become apparent until one considers the Dutch exports of Sole to France :

Country	1981	1982	(tonnes)
Netherlands	1,672	4,776	

TABLE 25 **Dutch Exports of Dover Sole to France** (OECD 1984)

This large increase of Dutch exports to France led to the following increase of French imports of fresh Dover Sole.

French Imports	1980	1981	1982	(tonnes)
	3,011	2,534	6,716	

TABLE 26 **French Imports of Dover Sole** (OECD 1984 and 1982)

The increase in Dutch exports to France in 1982 was mainly responsible for the very large increase in imports. When one recalls that the South West is a major exporter of fresh Dover Sole to France, the reasoning here becomes clear. South West exports of Sole are primarily distributed to France, and therefore in direct competition with other imported supplies. It is a reasonable hypothesis to suggest that the very large increase in French imports of Sole from the Netherlands is at least partly responsible for the apparent slump in demand for South West Sole in 1982.

The method of testing this hypothesis is not as clear as it seems at first due to the lack of monthly data on Dutch exports. Instead, an approximation was used by interpolating the annual data to represent monthly exports. The newly created variable was then added to the single equation specification for Dover Sole with both price and quantity of Monkfish as substitutes; the results are presented in Tables 27 and 28.

In comparison with the original Dover Sole model in Table 3, the new version in Table 27 represents an improvement. The overall explanatory power has increased and the equation as a whole has increased in significance. Own quantity is much the same, while the substitute price of Monkfish has increased in absolute terms and in significance. On the surface, the new variable representing Dutch exports appears to perform well being significant with the correct sign, indicating that as Dutch exports to France increase then the price of Dover Sole falls. The time trend has the same negative sign as before, while the overall

DOVER SOLE **TABLE 2[illegible]**

Dependent Variable = Price of Dover Sole

Substitute Variable = Price of Monkfish

Also included = Quantity of Dutch Exports to France

Model	α	Q_{DS}	P_{mo}	Q Dutch	T	F	M	A	M	J	J	A	S	O	N	D
Co-efficients	13.50	-0.00011	0.483	-0.000017	-0.0156	0.41	0.07	-1.50	-1.08	1.64	2.95	1.62	2.56	1.49	1.32	2.78
* t Statistics	* 8.57	-1.41	* 3.00	* -2.64	-0.75	0.42	0.07	-1.67	-1.09	1.77	* 3.26	1.77	* 2.68	1.63	1.41	* 2.33

Summary Statistics **R^2 = 59.3% DW = 1.92 F = 6.63* R^2 = 69.8% $\hat{p}$ = 0.2882

* Significant at the 95% level ** adjusted for degrees of freedom.

DOVER SOLE **TABLE 28**

Dependent Variable = Price of Dover Sole

Substitute Variable = Quantity of Monkfish

Also included = Quantity of Dutch Exports to France

Model	α	Q_{DS}	Q_{mo}	Q Dutch	T	F	M	A	M	J	J	A	S	O	N	D
Co-efficients	16.35	-0.00011	-0.000021	-0.000016	0.0237	0.605	1.08	-1.17	-0.07	2.78	4.33	2.35	3.87	2.35	2.22	3.81
* t Statistics	* 12.74	-1.30	-0.42	-1.87	0.87	0.47	0.90	-0.97	-0.05	* 2.18	* 3.60	1.92	* 3.03	1.96	1.78	* 3.05

Summary Statistics **R^2 = 48.3% DW = 2.01 F = 4.61* R^2 = 61.7% $\hat{p}$ = 0.4286

* Significant at the 95% level ** adjusted for degrees of freedom.

seasonal pattern is the same although it has been reduced in the individual significance of different variables. One interesting point worthy of note is that p, the estimated autocorrelation coefficient used in the transformation procedure, has fallen from 0.4906 to 0.2882. This is indicative of the fact that a proportion of the serial correlation in the residuals has been removed by the introduction of a new variable which helps to explain the apparent fall in demand for Dover Sole in the South West in 1982.

The Dover Sole model with Monkfish quantity as the substitute has lower explanatory power and overall significance than the price substitute model as was the case with the original models. In addition, the gain in explanatory power in this model is not as great in the substitute price model. One interesting feature to emerge from this model is that for the first time, the sign on the time trend is positive, although not statistically significant. A likely explanation is that the three quantity variables in tandem are picking up any downward trends resulting from quantity changes while the time trend monitors the residual shift in demand over time.

A final class of estimations reported on here concern the functional form of the model. It was argued in Section 7.2 that there might be reasons for questioning the linearity assumptions inherent in the original models. To check this, the original models were re-estimated after being transformed by natural logarithms. The model specification in this case is :

$$P_{it} = e^{\alpha_1 + \beta_2 \log Q_{it} + \beta_3 \log P_{jt} + \beta_4 \log t + \beta_5 D - \beta_{15} D + u_t} \quad (10)^4$$

4. For the demersal model, no substitute variable is included as discussed in the previous chapter.

The results are presented in Tables 29-34. In general terms, the log specification models perform in a very similar fashion to the original linear models. The explanatory power of each model is of the same magnitude as its linear predecessor although generally lower with the exception of the demersal model, for which the log specification appears a good fit. One point should be made with regard to the stability of the models. The estimates of the coefficients prior to correction for autocorrelation in the log models showed considerable variance to those estimates after the transformation procedure had been carried out. This problem did not emerge in the linear specification where the coefficients proved to be very stable during this procedure. Estimates of individual parameters in these log models tend to be very similar in magnitude, sign and statistical significance to estimates from the linear models.

One advantage of estimating models of the form of equation (10) is that the coefficients can be read directly from the equations as the corresponding price and cross-price flexibilities. In addition they are constant with regard to quantity and price in contrast to the ranges produced from the linear equations.

In fact, as can be seen from Table 35, on page 196, the estimates of the price flexibilities tend to corroborate one another. The log estimated price flexibilities tend to be lower because the linear estimates were over a range of quantities for illustrative purposes. For the individual species, the relevant linear flexibility is the lower one owing to the fact that most landed quantities lie at the bottom of the estimation range. For demersal, the opposite is true as the quantity landed is often large.

DOVER SOLE **TABLE 29**

Dependent Variable = Loge Price

Substitute Variable = Loge Price of Monkfish

Model	α	Loge QDS	Loge Pmo	Loge T	F	M	A	M	J	J	A	S	O	N	D
Co-efficients	2.79	-0.054	0.171	-0.002	0.13	0.11	-0.08	0.06	0.32	0.38	0.20	0.31	0.19	0.20	0.35
*	*		*						*	*	*	*		*	*
t Statistics	6.23	-1.23	2.03	-1.50	1.21	1.14	-0.85	0.53	3.32	3.94	2.11	3.04	2.00	2.06	3.56

Summary Statistics $^{**}R^2 = 49.3\%$ DW = 2.30 F = 5.03 $\hat{p} = 0.5583$

* Significant at the 95% level ** adjusted for degrees of freedom.

MONKFISH **TABLE 30**

Dependent Variable = Loge Price

Substitute Variable = Loge Price of Dover Sole

Model	α	Loge Qmo	Loge PDS	Loge T	F	M	A	M	J	J	A	S	O	N	D
Co-efficients	2.12	-0.188	0.552	0.018	-0.128	-0.02	0.20	0.16	-0.13	-0.17	-0.06	-0.08	-0.03	-0.15	-0.4[illegible]
* t Statistics	* 3.14	* -3.93	* 2.99	* 4.84	* -2.14	-0.13	1.58	1.28	-0.95	-1.18	-0.47	-0.53	-0.21	-1.03	* -2.5[illegible]

Summary Statistics ** R^2 = 28.8% DW = 2.59 $\hat{p}$ = 0.5278

* Significant at the 95% level ** adjusted for degrees of freedom.

LEMON SOLE | **TABLE 31**

Dependent Variable = Loge Price

Substitute Variable = Loge Price of Plaice

Model	α	Loge QLS	Loge PPL	Loge T	F	M	A	M	J	J	A	S	O	N	D
Co-efficients	2.17	-0.07	0.180	0.005	0.18	0.10	-0.25	-0.29	-0.14	-0.23	0.06	-0.83	0.23	0.04	0.2[illegible]
* t Statistics	* 4.50	-1.47	1.32	1.14	1.20	0.79	-1.96	-1.78	-0.93	-1.49	0.39	-0.31	1.24	0.16	1.18

Summary Statistics **R^2 = 54.2% DW = 1.93 F = 5.91 $\hat{p}$ = 0.5120

* Significant at the 95% level ** adjusted for degrees of freedom.

PLAICE **TABLE 32**

Dependent Variable = Loge Price

Substitute Variable = Loge Price of Lemon Sole

Model	α	Loge Q_{PL}	Loge Pmo	Loge T	F	M	A	M	J	J	A	S	O	N	D
Co-efficients	2.28	-0.177	0.194	-0.05	-0.49	-0.16	-0.10	0.21	0.17	0.28	0.30	0.27	0.24	0.39	0.23
*	*	*			*			*		*	*	*	*	*	
t Statistics	3.34	-3.21	0.98	-1.46	-4.59	-1.53	-0.92	2.08	1.53	2.49	2.80	2.46	2.23	3.69	1.95

Summary Statistics **R^2 = 79.6% DW = 1.91 F = 17.1 $\hat{p}$ = 0.3913

* Significant at the 95% level ** adjusted for degrees of freedom.

<u>**HAKE**</u> <u>**TABLE 33**</u>

Dependent Variable = Loge Price

Substitute Variable = Loge Price of Dover Sole

Model	α	Loge Q_H	Loge P_{DS}	Loge T	F	M	A	M	J	J	A	S	O	N	D
Co-efficients	1.19	0.012	0.123	0.02	0.13	0.28	0.16	0.05	0.16	-0.01	0.19	0.27	0.30	0.04	0.23
* t Statistics	1.92	0.25	0.53	0.20	0.56	1.29	0.78	0.25	0.76	-0.05	0.89	1.26	1.43	0.16	1.[illegible]

Summary Statistics ** R^2 = 0% DW = 1.97 $\hat{p}$ = 0.4467

* Significant at the 95% level ** adjusted for degrees of freedom.

DEMERSAL

TABLE 34

Dependent Variable = Loge Price

Model	α	Loge Q_D	Loge t	F	M	A	M	J	J	A	S	O	N	D
Co-efficients	3.62	-0.194	0.046	-0.09	0.024	-0.057	-0.079	-0.059	-0.043	0.025	0.069	0.226	0.064	0.133
*	*	*	*									*		
t Statistics	8.33	-4.81	2.52	-1.52	0.39	-0.94	-1.29	-0.96	-0.70	0.41	1.14	3.69	1.03	2.05

Summary Statistics ** R^2 = 66.2% DW = 1.98 F = 9.75* R^2 = 73.8% $\hat{p}$ = 0.2375

Obs = 59

* Significant at the 95% level ** adjusted for degrees of freedom.

Species	Linear	Log
Dover Sole	0.05 - 1.08	0.054
Monkfish	0.21 - 5.73	0.188
Lemon Sole	0.13 - 17.00	0.07
Plaice	0.15 - 11.23	0.177
Demersal	0.09 - 0.22	0.194

TABLE 35 Linear and Logarithmic Price Flexibilities

The corresponding estimates of the cross price flexibility of demand for both models follow the same pattern as above and again are very similar, as can be seen in Table 36 :

Species	Linear	Log
Dover Sole	0.03 - 0.24	0.171
Monkfish	0.04 - 0.47	0.552
Lemon Sole	0.08 - 0.45	0.180
Plaice	0.06 - 0.38	0.194

TABLE 36 Linear and Logarithmic Cross Price Flexibilities

7.4 Forecasting

7.4.1 Model Validation

Before any of the models estimated in the previous chapter can be used to forecast future levels of prices paid by port merchants for major demersal species, several issues need to be resolved. The first of these is to validate or check the models in terms of their forecasting accuracy. Secondly, is to determine which form of the model is the most appropriate for each species. Finally, some thought needs to be given to the use of independent variables for forecasting in future contexts when their values are not known, to enable determination of the expected value of the dependent variable price.

The validation of the models for a period when the independent and dependent variables are known is important for two reasons. Firstly, it gives a good method for not only checking model accuracy, but also whether the original model specification was in fact correct. Secondly, knowledge of the forecast error provides information likely to be useful when forecasting for periods when the actual values of price are not known.

The method of validation adopted was to use the different models to forecast monthly prices for 1982, and to then compute the mean square error (MSE) for each model to enable the comparison of the accuracy between different models of the same species. Obviously, not only are the independent and dependent variables known in 1982, but this was also the last year in the estimation period, so one would expect the models to perform reasonably well. The major deficiency with this method of model checking is that one cannot test whether there has been any major change in the structural parameters after the end of the estimation period. A more desirable method would have been to forecast 1983 prices using the models and to check against 1983 actual prices to test the stability of the structural parameters.[1] Nevertheless, the assumption of stable future parameters is essential to any forecasting work. Therefore 1982 forecasts should provide a good guide to model accuracy.

For Dover Sole, four models were used to forecast 1982 prices: price substitute, quantity substitute, price substitute and Dutch exports, and the log form of the price substitute. The performance of these four models is shown graphically in Figures 1-4 (which can be found in Appendix 4).

The first model with substitute price appears to track the actual price well until May, whereafter with the exception of August, the model consistently overforecasts price. The reason for this must surely be the fact that demand parameters changed in the latter half of 1982 as discussed earlier, with price not reaching its seasonal peak. Also the model was estimated over a five year period, the forecast is based upon that five year estimate and does not account for the apparent fall in demand apparent in 1982, as distinct from other years, with the resulting upward bias in the forecast. The reasons behind the change in Dover Sole in 1982 were discussed in the last section, but it is important to state that if the increase in Dutch exports to France marks the beginning of a new trend, then usage of the model in Figure 1 to forecast will result in spurious forecasts subject to a large degree of error.

The Dover Sole model with quantity as the substitute also suffers from an upward bias in the forecast value for price at the at the latter end of the year, presumably for the same reasons.

---

1. Unfortunately, detailed price and quantity data for 1983 had not been released at the time of writing.

However, this model does have a smaller mean square error suggesting that it is a marginally better forecaster than the first model.

Figure 3 shows the forecasts produced by the model which included the quantity of Dutch exports to France as well as price being the substitute. One can see that the opposite problem to the above models seems to have occurred. Not until September does the forecast price begin to approach the actual price. It almost appears that the inclusion of the export variable has had too much effect upon forecast price. Perhaps a monthly breakdown of exports, rather than interpolation, would have produced a better forecast. The value of the mean square error indicates that this model is a worse overall forecaster than the above two.

The last model tested, was the log transformation of the original price substitute model and is shown in Figure 4. Not only does this model produce forecasts higher than actual price, but much more so than the original model. This suggests that this transformation was in fact incorrect. The mean square error is by far the highest of the four models.

In terms of forecasting accuracy, the quantity substitute model produces the forecasts with the smallest mean square error. However, this model is unable to forecast the somewhat lower than expected actual price at the end of the year. The degree of accuracy to which this model can forecast price in the future is dependent upon whether the structural change in 1982 was a one off occurrence or the development of a new influence upon the demand for Dover Sole. If it is the latter, then forecasts of the price of Dover Sole will be subject to a high degree of forecast error.

Figures 5 and 6 show the results of the Monkfish models with price and quantity of Dover Sole as substitutes respectively. The first model tracks the actual trend throughout the year relatively well, although with some degree of error, particularly in the latter half of the year. One surprising feature is the relative accuracy of the forecast given the poor performance of the original model. Even more surprising is the accuracy of the quantity substitute again given the poor performance of the original model and the poor performance of the quantity substitute variable. With the exception of August and September, very accurate forecasts are produced resulting in a much lower mean square error than for the price substitute model. The log transformation model provided very poor forecasts.

Two forecasts for the price of Lemon Sole are shown using the price substitute and quantity substitute models. These were the only two models to produce relatively accurate forecasts. The price substitute model performs reasonably well demonstrating the seasonal pattern in price. As with earlier models though, there is a tendency for the model to consistently forecast higher prices in the latter half of the year. The same pattern appears in the quantity substitute model which proves to be an inferior forecaster than the original model.

The Plaice model with price as the substitute forecasts well except for the beginning and end of the year, as shown in Figure 9. The largest individual forecast error occurs in February when the large negative seasonal coefficient in the model produces a very low forecast for that month. The quantity substitute model also forecasts well apart from the major discrepancy at the beginning of the year, although this model produces a higher mean square error than the first.

The final model reported on here is the Demersal forecasts. There appears little point in using the Hake models due to the apparent failure in estimation. Figure 11 shows the original model to be a good forecaster of average demersal price. In contrast with all other models, the log version actually produces a superior forecast and smaller mean square error as seen in Figure 12. In fact, this model produces the most accurate forecast of all the other species models.

In general, this exercise of validating the models by forecasting 1982 prices has demonstrated with one or two exceptions, the accuracy of the models and the validity of the model specifications.

7.4.2 Forecasting Method

Using the models to forecast 1982 prices was obviously going to provide relatively accurate forecasts, for the models were in part estimated from 1982 data and also for that period all of the independent variables were known with certainty. However, using the models to forecast post 1982, introduces several potential sources of error which need to be considered.

Firstly, it must be assumed for the purposes of forecasting, that the parameters of the equations remain stable after 1982. If major structural shifts have occurred changing the demand parameters then erroneous forecasts will be the result. Without producing estimated equations for this later period, it is very difficult to check this assumption. There are, however, certain situations and developments which may have affected the demand parameters of port merchants after 1982.

The first of these has already been mentioned and relates to the international environment. It has to be assumed that the many international factors which could affect demand after 1982 remain stable. For Dover Sole and Monkfish, this is a somewhat tenuous assumption. Both species are subject to international competition which might affect the demand for individual species. It has already been suggested that in 1982 the demand parameters for Dover Sole were altered by increased Dutch exports to France. Given the poor explanatory power of these two models and their vulnerability to the international situation, future forecasts from these two models must be treated with caution.

A second factor relates to the enforcement of annual quotas for major species enforced after 1982. Actual quotas for Dover Sole, Monkfish, Plaice and Hake have been enforced since 1984; Lemon Sole and Total Demersal are non-quota. The question here is whether the independent allocation and enforcement of quota levels is likely to have altered demand parameters for those species. It is fair to say that quota levels are only likely to have an effect if changes in quotas are very large. An extreme example of such a situation relates to the North Sea Herring fishing in the early 1980's. Zero Total Allowable Catches resulted in processors shifting their demand away from domestic to imported herring. Not only did this supply change result in zero demand, but also induced a lagged shift in consumer demand for Herring. When the fishery was re-opened, consumer acceptance of fresh domestic Herring was reduced from previous levels, as witnessed by the promotional campaign for kippers carried out by the Sea Fish Industry Authority. In general, though, quota levels for South West species have been in part determined by previous catch levels due to insufficient biological data. The result has been that quota levels have not altered significantly from previous levels, thus causing movements along the demand curve rather than extreme changes in the demand parameters.

The one exception to this argument is the recent pressure stock method of managing Dover Sole quotas in the South West. Quotas are now set on a two monthly basis throughout the year. At any time, the fishing can be closed for indefinite periods to ensure the quota is not exceeded in any particular two monthly period. Effectively, this has meant that supply has been totally curtailed from certain areas. Changes such as this will obviously create changes in demand parameters in the short run. Not only will the relationship between price and quantity be severely altered, but also the substitute relationship and the particular monthly seasonal coefficient. Owing to the fact that these are short term fluctuations, one would expect that expectations about future quota levels would lead to a return to the original parameters rather than a new set of parameters as supply settles down again. This view is, of course, conditional upon several factors. In order to avert the disruptive influence of this type of management scheme, merchants may in fact attempt to move to other species or obtain supplies elsewhere. If this is the case, then when supply returns to more normal levels after a closure, demand parameters may be altered. An additional problem might be that when Sole fishing is stopped in the South West, foreign vessels may in fact be allowed to continue fishing and begin to capture the export markets serviced by South West port merchants. When supply levels are not subject to very low levels, one would expect that in the short term demand parameters would return to their original levels. However, it may well be that successive stops on Sole fishing might lead to a more gradual longer term change in parameters. The Dover Sole quotas set for 1986 have made some attempt to lessen the disruptive impact of closing the fishing. In fact the quotas have been deliberately set to match the seasonal availability and the seasonal demand with larger quotas towards the end of the year. This is not the same as saying that demand influences supply directly as supply is still predetermined. In fact this leads on to a more general point regarding quotas. The determination of quota levels based on previous catch levels and biological factors reinforces the inelastic supply assumption, meaning that the estimated structure of the models will continue to be valid. The issue of quotas and their implication for parameter stability is a complex one; however, it appears from the above that only short term effects are likely and these being only for those species subject to the pressure stock form of management. The introduction of quotas reinforces rather than diminishes the inelastic supply structure of the models.

There are, of course, many possible factors which may cause shifts in demand not accounted for by the estimated models in the future. Of these, one recent development may prove to be very important; the question of Spanish entry into the European Economic Community. At present, Spain has only limited access to waters around the South West and as such one might expect that there has been little impact upon the local industry as yet. It may prove that in the future, Spanish entry will have a detrimental effect upon the local industry rather than the beneficial effect predicted by some sections of the industry. Rather than providing increased export opportunities through the lowering of tariff barriers, increased Spanish activity in South West waters may in fact reduce export opportunities. If Spanish vessels are allowed to take large quantities of important species, such as Hake, Dover Sole and Monkfish, then they will be supplying the home market which was of course supplied by port merchants in the South West. This, if it were to happen, would lead to a shift downward in demand in merchant demand for these species in the South West.

This section has briefly considered some issues and developments which might affect the assumption of stable parameters necessary for forecasting. For many possible developments, it has to be assumed that the parameters of the estimated equations will remain the same. Other developments, and in particular quota enforcement, may lead to changing parameters, although the changes are likely to be short term. In any case, many of these changes are limited to Dover Sole, Monkfish and Hake. The Plaice, Lemon Sole and particularly the Total Demersal model are much less likely to suffer from these problems.

A different source of error relates to the fact that in forecasting the future, the independent variables are not known with certainty. There are two sources of error here. Firstly, the guessed value of an independent variable may be wrong thus producing an inaccurate forecast of the dependent variable. Secondly, it is dangerous to use values of the independent variables which differ greatly from the sample mean, for even if they were correct, they would produce unreliable forecasts.

The problem of preparing wholly unconditional forecasts in this context is alleviated somewhat. Conditionality enters that forecast through the presence of the time trend and the seasonal coefficients, assuming that the parameters remain stable. This leaves the problem of forecasting own quantity and substitute price for the individual species models, and own quantity for the Demersal model. In the Dover Sole model, quantity is to some extent given by the new management system which provides two monthly quotas. For assumption purposes, these figures can be broken down into monthly quantities and used as the independent variable for forecasting. For Monkfish and Plaice, annual quotas can be broken down to monthly quotas. These identical monthly quotas can then be seasonally adjusted by the use of seasonal coefficients estimated from a regression of quantity, 1978-1982, with January as the base year. The forecasting of substitute price is a more thorny problem. Most methods seem subject to error, yet a practical method is to use the time trend and seasonal coefficients of the substitute price demand equation extrapolated into the future to provide estimates of price. The remaining independent variable which needs forecasting is own quantity in the Lemon Sole and Total Demersal models. Again, a practical method is to estimate a regression of quantity on a time trend and matrix of dummy variables from 1978-1982, and then use these coefficients to extrapolate respective quantities into the future.

7.5 Summary

This Chapter has presented the results of the single equation models of demand. It was seen that the models were estimated with different degrees of success. The Lemon Sole, Plaice and Demersal models perform well while specific problems were identified with Dover Sole, Monkfish and Hake. With the exception of Hake, the remaining five models justify the single equation specification, based upon the inelastic supply assumption as demonstrated by the significance and plausibility of individual variables.

Apart from some specific problems, several potential general problems were identified. This led to a number of alternative specifications designed both to improve individual models and test completely different assumptions. With regard to improving individual models, little success was experienced with Monkfish and Hake, while the Dover Sole model was improved through the introduction of a new variable. With alternative simultaneous specifications, little success was had, while the changing of the functional form of the single equation models produced results which confirmed and reinforced the original model specification.

The conclusion to be drawn from this chapter is that the estimation of the demand relationships facing port merchants for major species was met with considerable success, and marks the first stage in the model development.

CHAPTER 8

THE COST AND PRICING MODEL

8.1 Introduction

The ability to explain and predict movements in purchase prices focuses on the major cost facing the port merchant sector located at Plymouth, Newlyn and Brixham. In order to determine how supply variation works through the system to affect financial performance, other costs need to be taken into account. In particular, it is necessary to determine cost functions which describe the activities performed by port merchants and how they vary with different supply levels. In addition, a model of the pricing method used by port merchants needs to be developed to allow for the determination of revenues.

Owing to the fact that company cost information is less accessible than landings and price data, the cost and pricing model of the port merchant sector developed in this chapter is based upon the sample data obtained through the survey of port merchants. It must also be noted that the model relates to total demersal costs and revenues, rather than for individual species or shell fish, because the nature of the cost data refers to demersal species as a whole.

Once the models have been developed, all elements are brought together at the end of this chapter to demonstrate the model's use in a forecasting context and to show how it can provide a detailed analysis of the position of the port merchant sector in 1982.

8.2 Model design

The data on costs from the sample of port merchants who specialised almost exclusively in demersal species, originally shown in Chapter 4, is reproduced below :

Table 1 Financial Performance of Port Merchants, 1982

	Value (£)	%
Cost of Fish	2,720,000	80.81
Gross Margin	646,000	19.19
Costs:		
Packaging	81,450	2.42
Communication	18,500	0.55
Documents	11,450	0.34
Ice	20,530	0.61
Salaries	136,000	4.04
Labour	68,000	2.02
Own Transport	24,570	0.73
Hire Transport	37,360	1.11
Other	85,160	2.53
Total Costs	483,020	14.35
Net Profit	162,980	4.84
Total Sales	3,366,000	100.00

The above costs incurred by port merchants, in addition to the cost of fish, can be represented by the simple model :

$$Cf = \alpha + \beta Q \qquad (1)$$

where :

Cf = The total cost of performing wholesale functions

α = Fixed cost.

β = Variable cost.

Q = Quantity.

A necessary first stage in determing an equation in the form of (1) above, is to separate the costs in Table 1 into fixed and variable categories. Some of the costs obviously vary with output and should be included in the variable category. The amount spent by port merchants on cardboard and polystyrene boxes and ice will vary directly with the amount of fish handled. Similarly, the cost of export documents and hire transport is dependent upon the quantity of fish exported and distributed inland. In addition, the short term movement of labour into and out of the merchanting sector suggests that this should be treated as a variable cost. These five categories can be summed to form a total variable cost from the sample data of £218,790. If one then divides this by the scale of output generated by the sample, 476,000 stone, an average variable cost coefficient of 0.46 pence per stone can be derived. This coefficient can be taken to represent the demersal sector at Plymouth, Newlyn and Brixham as a whole.

Of the remaining costs, the other category includes many expenses incurred through the lease of premises and general business expenditure. This category does not depend upon levels of output and therefore is included in the fixed cost category. Salaries, in the short term, can also be regarded as a fixed cost. The other two costs, communication and own transport, are to some extent variable but do not vary directly with output. For example port merchants are involved in regular communication with customers regarding transactions, yet the size of transaction does not influence the cost of communication. Similarly, own transport is used for making daily trips to and from the auction to collect fish for transport back to individual premises. These trips are made regardless of the quantity of fish purchased.

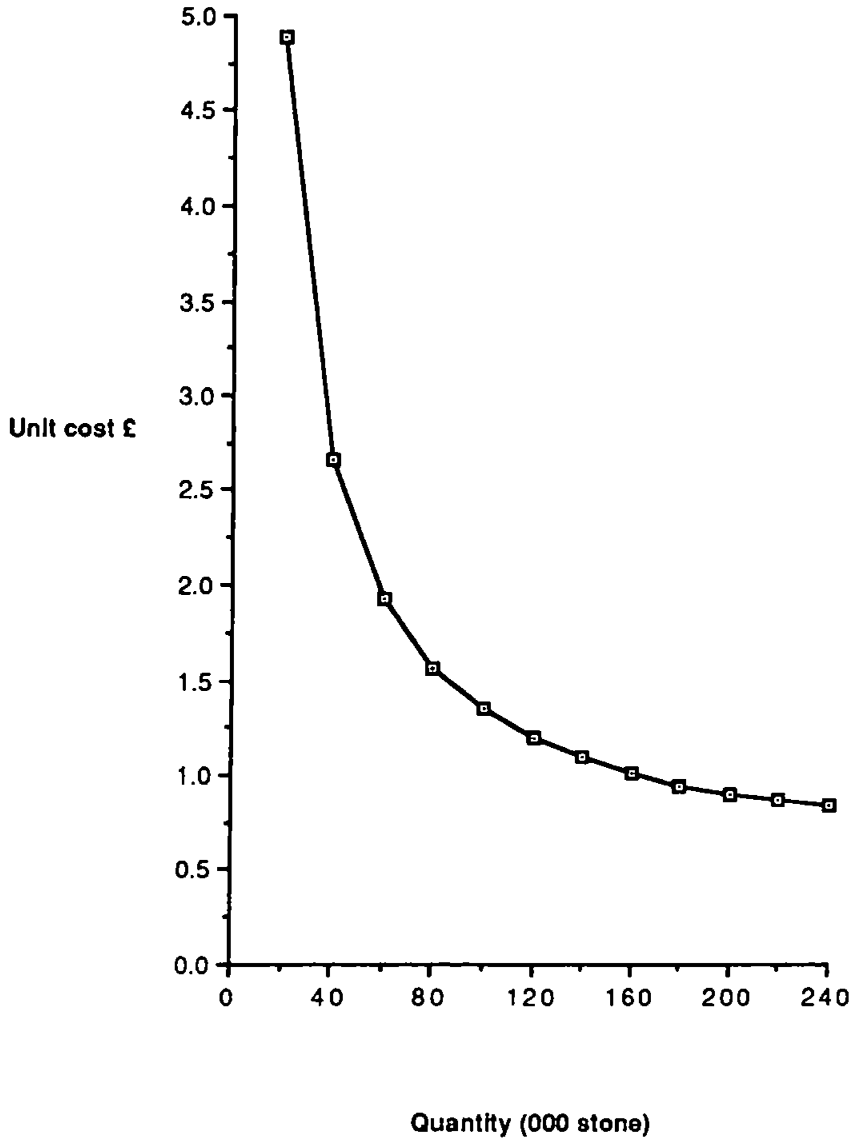
These categories can be summed to form a total fixed cost for the sample of £264,230. The necessary procedure to arrive an an estimate of the fixed cost for the demersal sector as a whole is different from that adopted for the variable cost component. Firstly, the sample quantity (476,000 stone) is divided into the total quantity of demersal fish landed at Plymouth, Newlyn and Brixham in 1982 (1,909,602 stone) to derive a conversion factor of 4.012. The sample fixed cost is then multiplied by this conversion factor to provide an estimate of the total fixed costs in 1982 incurred by port merchants at the three ports of £1,060,030. When this figure is divided by twelve to represent monthly fixed cost and added to the average variable cost coefficient, one has the following equation describing the monthly cost of performing wholesale functions for the merchanting sector at the three ports in 1982 :

$$Cf = £88,336 + 0.46\,Q \qquad (2)$$

The unit cost schedule using equation (2) for a range of quantities is presented in Figure 1 overleaf.

Figure 1

Average Total Cost Schedule



The short run average cost curve has the downward sloping shape as suggested by economic theory reflecting the spreading of the fixed cost component over larger quantities. For successively larger quantities, the average cost decreases by very small amounts.

This equation when combined with the demersal model of demand provides a method for forecasting the total demersal costs incurred by the port merchant sector at the three ports: the cost of fish, fixed costs and variable costs.

In addition to costs, a method of determining the selling prices and, therefore, total revenues is also needed. One obvious procedure is to use the information on the gross margin provided by the sample. The gross margin can be regarded as that increase in the purchase price necessary to cover fixed and variable costs and provide a satisfactory level of net profit. When the gross margin is expressed as a percentage of the cost of fish, it corresponds to a mark-up of 23.75%. This value can then be taken to represent a constant percentage spread method of price determination operated by port merchants. Obviously, for individual species, this value will differ, but on average evens out to this value on demersal species as a group. Finally, an estimate of profitability can be made.

Having detailed the method of deriving the cost and pricing model, the assumptions involved in its development need to be examined in detail.

8.3 Key Assumptions

The most fundamental assumption involved in the development of the cost model is that all port merchants at Plymouth, Newlyn and Brixham face the same cost conditions as those in the sample, which might not be the case.

Costs between firms may vary due to features peculiar to individual firms. Firms may not all perform the same functions; they may use different methods of packing, they might employ more labour or they might use different forms of transport. Firms outside the sample might not have the same pattern of distribution as those in the sample. The importance of this lies in the fact that when deriving the cost model, some costs are peculiar to certain distribution channels, notably export documents and hire transport, While this is the case, in the model these costs are expressed across all distribution channels. If the firms outside the sample undertake more or less exporting or inland distribution, then not only will the pattern of distribution be different, but so will the unit costs when expressed across all different distribution channels as some costs will be relatively more or less important. Another possibility is that the scale of firms outside the sample might be different and costs might vary between firms due to the presence of economies of scale or for that matter diseconomies of scale.

The fundamental question is whether one can assume that all port merchants operate in a sufficiently homogenous manner to the sample so as to validate the cost model.

In support of this assumption, the first important point to be made is that the cost model is developed from a sample which actually represents a sizeable proportion of the total demersal sector. The cost model is based upon the aggregated cost structures of four port merchants, dealing almost exclusively in demersal species, whose total purchases in 1982 formed 26.4% of the total landed value of demersal species at Plymouth, Newlyn and Brixham.

Evidence in support of the homogeneity assumption of port merchant operation is also provided by the sample. One of the most striking features of the cost sample, when discussed in Chapter 5, was the degree of similarity between the cost structures of the individual merchants which comprised the sample. Furthermore, the wider sample of port merchants, whose purchases in 1982 represented 36.2% of the total landed value of demersal and shellfish species available to port merchants at the three ports, revealed very similar gross margins to those firms for which detailed cost data was obtained. If one excludes the one merchant whose margin was much higher than the rest of the sample due to a specialisation in shellfish, the gross margin on demersal fish in the wider sample was 20.48%. The aggregate gross margin from the detailed cost sample was very similar at 19.19%. This homogeneity within the cost sample together with the comparability of the gross margins between the two samples strongly suggests that cost structures throughout the demersal sector are likely to be very similar to the sample.

The principal reason for this is that fresh fish port merchanting is a very homogenous activity. The wider sample of port merchants revealed that all members of the sample specialising in demersal species performed the same functions as each other in the same way. All merchants jointly purchased demersal species from the auction and the boats in order to reduce dependence and therefore risk on any one form of supply. The principal functions performed by all merchants were the cleaning, grading and packaging of fish. Very little processing, freezing or filleting was observed with the result that weight loss is insignificant in distorting cost structures. In addition, certain conventions were observed common to all merchants: inland wholesale markets are traditionally supplied with fish packed in cardboard boxes, while export markets are supplied with fish packed in polystyrene boxes. For reasons of efficiency, all merchants in the sample utilise the major independent haulier in the region rather than undertaking their own distribution. In a similar vein, customers in the export market come to collect fish themselves. No merchant in the sample undertook transportation abroad. All in all, the observed functional similarity between merchants is undoubtedly the major reason for the similarity of cost structures through the sector as a whole.

Within the sample of port merchants, some evidence of differing patterns of distribution was found, and in particular that small merchants did not undertake much activity in the export market. As a result, one might reasonably expect unit costs to differ between firms who undertake more or less exporting. However, the cost sample is representative and covers a range of firms who all export to differing degrees. Therefore the cost model does account for differences in unit costs resulting from differences in export behaviour by presenting an average view of the sector. In essence, this is one example of the effects of different scales of operation upon unit cost structures. In general, any differences resulting from scale effects are incorporated in the model due to the representative nature of the sample which is comprised of differently sized firms. In any case, one would not expect the effects of economies of scale to be great, as the different sized firms in the sample demonstrated very similar unit cost structures.

The rationale for homogenous cost structures in the demersal sector can be traced to a more general set of reasons. All demersal port merchants are subject to a number of common pressures and constraints. The nature of the product itself dictates the performance of common functions. Perishability dictates the usage of ice and similar packaging materials. The relatively unstandardised nature of the product also necessitates the performance of common sorting functions. Variation in supply creates uncertainty and risk with the result that all merchants purchase from several sources, carry a wide range of species and distribute to a wide variety of markets. The proximity and communication between merchants is another factor prompting similar behaviour. A more fundamental reason relates to the market structure of the sector. All port merchants are operating in the same unified market environment, where they are purchasing demersal supplies from common sources, and competing with each other in the same markets. Due to the fact that they are price takers, merchants must accept the market price at the auction and also in the markets where they jointly sell. The point here is that purchase and selling prices of merchants are likely to be similar, both being dictated by the market rather than by the merchants themselves. The upshot of this is that firms with higher operating costs must either accept lower levels of profit or will find themselves unable to compete. This market pressure is another factor likely to induce homogeneity of operation and similar cost structures within the merchant sector.

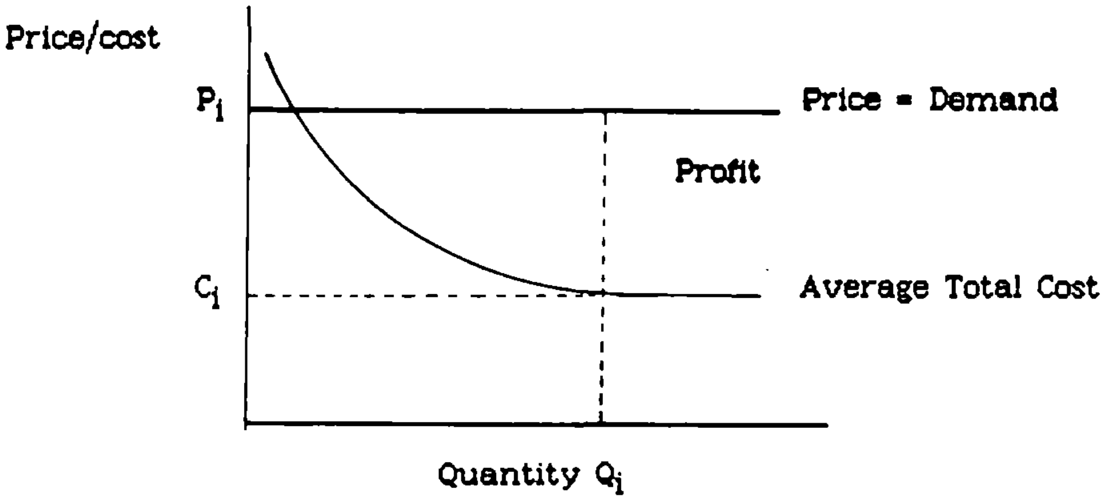
Given that the cost model is based solely upon demersal species, it is still important that the product mix of the sample is the same as for the sector as a whole. If the sample was based upon firms which tended to concentrate upon high unit value species, then the cost and pricing model might present a distorted view of the demersal sector as a whole. However, in the sample, it was found that all merchants handled a wide variety of demersal species rather than concentrating upon a narrow product mix as a way of reducing risk in the face of a variable supply. Given this behaviour, one can in fact show that the product mix of the sample bears close resemblance to that for the whole sector. In 1982, the average price per store paid by the cost sample was £5.71 pence, whereas the average price paid for all demersal landings at the three ports was £5.88 pence per stone. This feature provides further evidence of the representative nature of the sample.

A final possible distorting factor should not be ignored. Landings of demersal species at the three ports do not constitute the only source of supply to port merchants located there. Demeral supplies also come overland from smaller ports to be auctioned along with indigenous supplies at the major ports. The amount of fish actually landed is, therefore, an underestimate of the amount of fish actually handled by merchants, although it is not possible to determine to what extent. As in the case of merchants handling shellfish, this feature will only invalidate the cost model if the unit cost structure for overland fish is different to that for demersal species landed at the three ports. It has already been established that the homogeneity of functions between merchants leads to very similar unit cost structures and that this is a major factor behind the representative nature of the sample. Therefore, it is highly probable that the cost structure for overland demersal supplies is very similar to that for indigenous landings. The effect of this feature on the model in no way questions the validity of the model, rather it means that the model is an accurate representation of demeral fish landed at the three ports only and does not account for overland fish. However, demersal landings at the three ports represent over 82% of the region's total demersal landings by value, and therefore the cost model upgraded to represent the three major ports still represents the bulk of the sector's activity.

The conclusion with regard to upgrading the sample cost data to represent the demersal sector at Plymouth, Newlyn and Brixham is valid for several reasons. The cost sample represents a sizeable proportion of the industry, where considerable evidence and additional reasoning suggest that all merchants operate in a sufficiently homogeneous manner to the sample so as to validate the cost model. Where differences in unit costs might be expected to occur due to different scales and patterns of distribution, the representative nature of the model based on the sample accounts for any differences. It was also argued that possible distortions to the model do not invalidate it, but just mean that it is an accurate representation of the indigenous demersal sector at the three major ports.

There are, however, more specific assumptions which need to be considered. In the model, costs have been separated into clear cut fixed and variable categories. In the short term monthly basis of the model, there are costs which do not vary with output and can be regarded as fixed, such as rates, rents and salaries. Similarly, there are those costs such as packing and ice which will vary directly in a linear fashion with output. The problem arises over such costs as communications, documents and own transport. Clearly, these costs are not totally fixed in the short run nor do they vary in a linear fashion with output. For example, assuming patterns of distribution remain the same, a ten percent increase in output will not result in a ten percent increase in communication costs. Costs such as these might vary with different levels of output but not in such a way as they can be classified as direct variable costs. In cases such as these, one really has a category of semi-variable costs which contain both a fixed and a variable element. The problem is that without detailed knowledge of how these costs vary with output one has to decide how to allocate them. The tenet here is that communication and own transport costs can be considered relatively independent of output and are therefore included in the fixed cost category although this is something of a simplification. For example, labour costs will vary with output as more workers are taken on to cope with increased quantities, but it is doubtful if labour costs rise in a linear function with output. If labour was paid on a time-rate basis, the relationship might approximate a linear trend. However, if labour is paid a weekly flat wage then the relationship might follow a stepped pattern representing the condition where additional labour is taken on at higher levels of output. The linearity assumption in this case is therefore likely to be an approximation of the true relationship. The other variable costs, packing, ice and hire transport follow a linear relationship more obviously, assuming that discounts do not exist for bulk purchasing and usage.

The evidence on industrial costs tends to support the development and shape of the short run average cost curve up to a point. Hay and Morris conclude from a survey of empirical studies of industrial cost curves that there is evidence to support fixed cost coefficients in production in the short term. Similarly, they conclude that the short run average cost curve does fall with increasing levels of output as seen in Figure 1 (Hay and Morris, 1979). The one problem is that at higher levels of output, both the theory and the evidence suggest that the short run average cost curve rises reflecting the presence of diseconomics of scale in the short term at higher output levels. In the case of the cost model developed here, short run average cost continues to fall with higher levels of output and does not follow the familiar U shaped pattern. The reason is that fixed costs are being spread over larger quantities and unit variable costs form the same linear relation with quantity over all possible quantities. The cost model is effectively saying that economies of scale in the demersal merchant sector continue to exist at higher levels of output and that at no stage do diseconomies become present with the result that there is no cost imposed limit to the capacity of the merchanting sector. To illustrate the problem, consider the following model of an individual port merchant :



<u>Figure 2</u> **<u>Port Merchants with no Diseconomies of Scale</u>**

In the above model, the horizontal demand curve represents the assumption made earlier that the individual merchant is a price taker.[1] The model in Figure 2 suggests that there is a definite tendency for a firm to produce as much as possible, as profit continually increases with quantity reflecting the lack of diseconomies of scale in the model. If this were a true representation of the situation facing individual merchants, then in time the merchanting sector would tend towards a monopoly market structure as one firm would attempt to become dominant by buying all the available supplies forcing others out of business. In reality, of course, the individual merchant does face a series of constraints upon his scale of operation; there are physical capacity

---

1. The industry demand curve has the downward slope as estimated in the demersal model.

constraints in the short run, also total supply available is the ultimate constraint upon capacity. In addition, the demersal model of demand shows that seasonal variations place constraints upon price. Even bearing in mind these other constraints, the model of the merchant with a continually downward sloping short run average cost curve suggests that merchants will continually be attempting to increase their profits by increasing the amount of supplies they handle. If this were a true representation of the cost structure of port merchants, then in recent years, one would have expected to see many merchants closing down and the remaining ones growing in size to dominate fish buying and a generally volatile market structure. While undoubtedly, some merchants have gone out of business, the relatively stable structure and co-existence of large, medium and small merchants at the three ports suggests that the cost model developed in this chapter is not wholly accurate.

In reality, it is much more likely that the situation facing the individual port merchant is of the form shown in Figure 3 below.

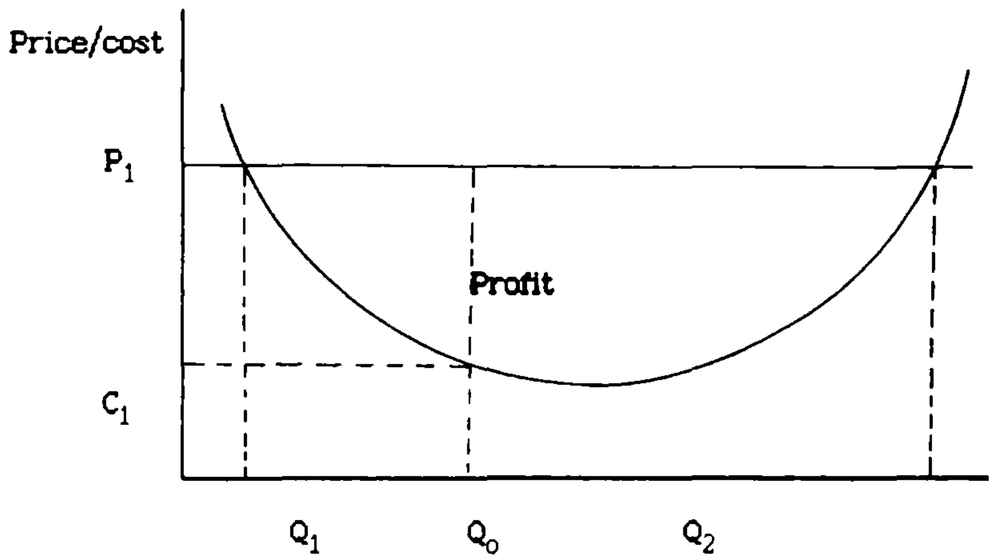


Figure 3 Port Merchants with Diseconomies of Scale

In this model, the short run average cost curve rises again at higher levels of output and imposes a cost constraint through the presence of diseconomies of scale. Any merchant operating at a scale beyond Q_2 would operate at a loss, as high unit costs exceeded price and a loss making situation arose. A more realistic scenario than the continually downward sloping cost curve, this model suggests that merchants are seeking to operate somewhere between Q_1 and Q_2 in order to realise a reasonable profit. Rather than seeking to continually increase output in the short term, it is more likely that merchants are seeking to operate around a certain level of output somewhere near the optimum scale. It is more likely that bankruptcies in the merchanting sector will occur when individual firms are unable to purchase enough supplies and are forced to operate to the left of Q_1. In such a situation, individual firms cannot set prices much higher than the market price as the market will not accept them with the result that they will go out of business. The scenario appears more plausible than that with the downward sloping cost curve and the industry tending to monopoly.

Unfortunately, it is not possible to derive accurate enough cost data to determine the exact nature of the short run average cost curve for the sector and the downward sloping curve has to be used. The implication of using this curve (which probably bears a closer resemblance to the long run average cost curve where no inputs are fixed) is that at higher levels of output, the cost model will have a tendency to overforecast profitability in the industry, as even for the industry as a whole in the short term, some inputs are fixed imposing a cost constraint through the presence of diseconomies of scale. A slightly alternative scenario with the same result, would be if at higher levels of output additional labour was employed and the unit variable cost coefficient changed to a higher level. If this is the case, then the use of a constant unit variable cost coefficient will lead to an over-estimation of profitability through the underestimation of costs.

Another set of assumptions have been made concerning the method of determining the selling price of demersal fish. Under the constant percentage spread approach, it is assumed that on average across all species that the mark up is fixed. In other words the model of price determination is :

$$\text{Price} = \text{Cost} + \text{Profit} \qquad (3)$$

Under this form of cost plus pricing, a further assumption made is that demand conditions impose no constraint upon the selling prices offered by port merchants. In other words, the following model does not apply :

$$\text{Profit} = \text{Price} - \text{Cost} \qquad (4)$$

There are in fact good reasons for supposing that the model in (3) with the fixed mark up is a valid representation of the pricing approach adopted by merchants. The model in (4) which takes demand into account in the pricing process supposes that merchants have good information on demand conditions locally, in the rest of the country and abroad, on which to base their decisions. It also supposes that merchants have the time to work this form of pricing out in detail. For most merchants, selling prices are determined very quickly and often negotiated over the telephone on a daily basis. There is no time for determining a price in the face of demand which will maximise the merchants' profit, the detail on costs needed would make this method of price determination prohibitive.

Rather, it is more plausible that merchants work on a rule of thumb basis. They have a basic idea of the mark up needed to cover unit costs and make a reasonable profit, which results in a relatively constant mark-up being applied. The fact that the model of price determination operated here is a constant percentage spread rather than an absolute percentage spread is wholly consistent with the shape of the short run average cost curve. In effect, the constant percentage spread provides merchants with a method of covering unit costs and obtaining a reasonably stable level of unit profit in the face of a variable supply. For example 24 percent of eight pounds implies a greater margin per stone than 24 percent of five pounds. The reason is that high prices are usually associated with low quantities, and as such unit costs will be high necessitating a high margin to cover costs and return a profit. Similarly, where one has large quantities associated with comparatively low purchase prices, the constant percentage spread provides a relatively small margin as unit costs will be much lower. The operation of an absolute percentage spread would result in low profit rates when prices and unit costs are higher than the constant percentage spread.

The assertion above that this pricing approach takes no account of demand conditions is not wholly accurate, as will be seen in the next chapter. The use of a constant mark up represents an acceptable method of price determination which really lies between the two models in (3) and (4) above. For example, if demand conditions work through the system and influence the derived demand of port merchants by altering purchase prices, then the constant spread will be different according to the change in purchase price. One could also argue that large quantities will produce smaller margins through lower prices, reflecting the fact that the marketplace will not accept high price levels when quantity is high. So while it appears that demand conditions are built into the pricing model, it does not alter the fact that it is a cost plus method of the form in (3) above.

A further point concerns the stability of the mark-up, and the representativeness of the sample mark-up of nearly 24 percent. While this produces varying unit margins, it is likely that the mark-up will remain constant, and similar throughout the demersal sector for homogenous species. Deviation away from the common level will either result in lower profits or higher prices which might leave fish unsold. There is, therefore, a natural tendency for merchants handling similar species and selling in similar markets to operate the same level of mark up.

The industrial evidence on pricing is varied, with many different pricing approaches adopted, but generally supports the pricing model developed above. Hay and Morris report that common methods include fixed margin and average cost plus pricing, of which the constant percentage spread is one form. Hay and Morris also argue that many firms do in fact set prices without a detailed consideration of the prevailing demand conditions (Hay and Morris, 1979). Young reports that both absolute and constant percentage spread approaches are used in the port wholesaling sector, the former mainly for frozen fish and the latter for fresh fish where there is a variable supply (Young T., 1976). In addition the Price Commission also found that the constant percentage spread pricing method was the predominant approach used in the fresh fish sector (HMSO, 1976). Finally Prochaska in his study of the King Mackerel marketing system finds that there is an inverse relationship between levels of supply and the unit gross margin which is certainly suggestive of a constant percentage spread pricing approach.

8.4 The Model Applied to 1982

The results provided by the model when applied to 1982 supply levels are presented in Table 2 and graphically in Figures 4 and 5, showing monthly profit and monthly unit profit, below. A key is also provided for Table 2.

The first stage in the application of the model is to determine how actual monthly supplies of demersal fish determine the purchase prices paid by port merchants. For this, the 1982 monthly stonnages of demersal fish are substituted into the logarithmic demersal model of demand, the most accurate of the demersal forecasting models. From this, one derives a monthly estimate of the unit cost of demersal fish to the port merchant sector at January 1978 prices. These values are then reflated to represent 1982 nominal prices in order to ensure compatibility with the cost model which is also expressed in 1982 terms. The resulting monthly unit cost of fish is shown in the second column of Table 1. When multiplied by the quantity, one arrives at an estimate of the total monthly cost of fish to the port merchants (column 3).

The next stage is the determination of the costs of performing port merchanting functions. This is achieved by using the cost model to determine monthly fixed and variable costs, shown in columns 4 and 5 of Table 2. When these costs are added to the total cost of fish, one has an estimate of the total monthly costs incurred by the port merchant sector in 1982, shown in column 6.

The determination of revenues is achieved by use of the pricing model. The constant percentage spread mark up of 23.75% is applied to each monthly purchase price in order to determine the monthly selling price, which is shown in column 8. The selling price multiplied by the quantity gives total revenue, and total

1982 DEMERSAL FORECAST *

TABLE 2

Month	Q	PP	C of Fish	FC	VC	TC	Unit	SP	TR	Unit P/L	P/L	P % TR
J	108,701	6.02	654,380	88,336	50,003	792,719	7.29	7.45	809,822	0.16	17,103	2.11%
F	176,039	4.99	878,435	88,336	80,978	1,047,749	5.95	6.18	1,087,921	0.23	40,172	3.69%
M	144,271	5.88	848,314	88,336	66,365	1,003,015	6.95	7.28	1,050,293	0.33	47,278	4.50%
A	178,904	5.23	935,668	88,336	82,296	1,106,300	6.18	6.47	1,157,509	0.29	51,209	4.42%
M	141,244	5.36	757,068	88,336	64,972	910,376	6.45	6.63	936,448	0.18	26,072	2.78%
J	227,215	5.03	1,142,891	88,336	104,519	1,335,746	5.88	6.23	1,415,549	0.35	79,803	5.64%
J	209,963	5.09	1,068,712	88,336	96,583	1,253,631	5.97	6.30	1,322,767	0.33	69,136	5.23%
A	179,741	5.71	1,026,321	88,336	82,681	1,197,338	6.66	7.07	1,270,079	0.41	73,431	5.78%
S	136,765	6.35	868,458	88,336	62,912	1,019,706	7.46	7.86	1,074,973	0.40	55,267	5.14%
O	137,390	7.54	1,035,921	88,336	63,199	1,187,456	8.64	9.33	1,281,849	0.69	94,393	7.36%
N	100,193	6.92	693,336	88,336	46,089	827,761	8.26	8.56	857,652	0.30	29,891	3.48%
D	169,091	6.70	1,132,910	88,336	77,782	1,299,028	7.68	8.29	1,401,764	0.61	102,736	7.33%

Annual Summary

Total Revenue = £13,667,316   Total Profit = £686,491   * At 1982 Prices

Total Cost = £12,980,825   Average rate of net profit = % 5.02

revenue minus total cost gives an estimate of the monthly level of profit or loss, shown in column 11.

As can be seen from Table 2, the application of the model to 1982 levels of supply results in an estimated annual profit of £686,491 or 5.02 per cent of total revenue. As one would expect, the results bear close resemblance in aggregate to the rate of profit of the detailed sample, as the sample data forms the basis of the cost and pricing models of the demersal sector at the three ports.

Table 3 : 1982 Demersal Forecast Key

Column	Variable
1	Actual monthly demersal quantity.
2	Forecast monthly purchase price.
3	Total monthly input cost of fish.
4	Monthly fixed cost.
5	Monthly variable cost.
6	Total monthly cost.
7	Unit total monthly cost.
8	Monthly unit selling price.
9	Monthly total revenue
10	Monthly Unit Profit/Loss
11	Monthly Total Profit/Loss.
12	Monthly Profit/Loss as a percentage of total revenue.

One particularly interesting feature of the results, concealed by the aggregate figure is the marked seasonal variation in profits. Figures 2 and 3 show graphically monthly profit and monthly unit profit, and quite clearly demonstrate a marked seasonal variation in addition to a generally upward trend throughout the year.

Figure 4

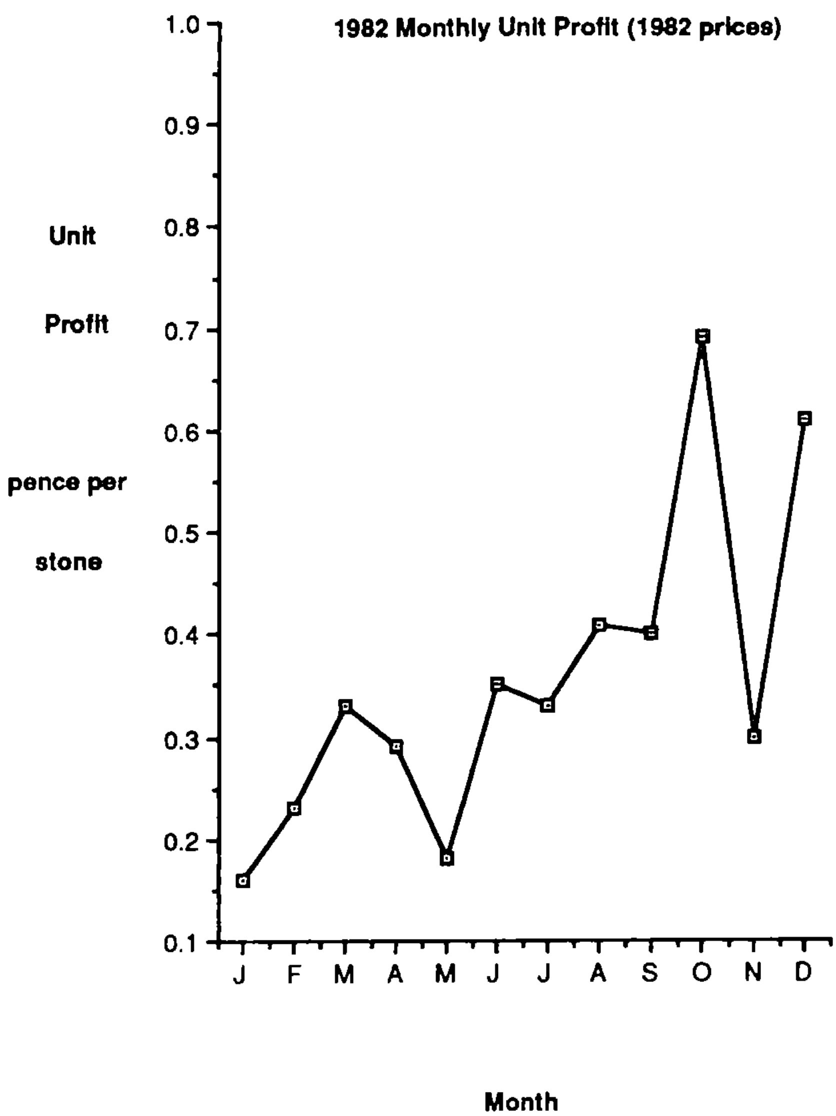

1982 Monthly Unit Profit (1982 prices)
Unit
Profit
pence per
stone
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
J F M A M J J A S O N D
Month

Figure 5

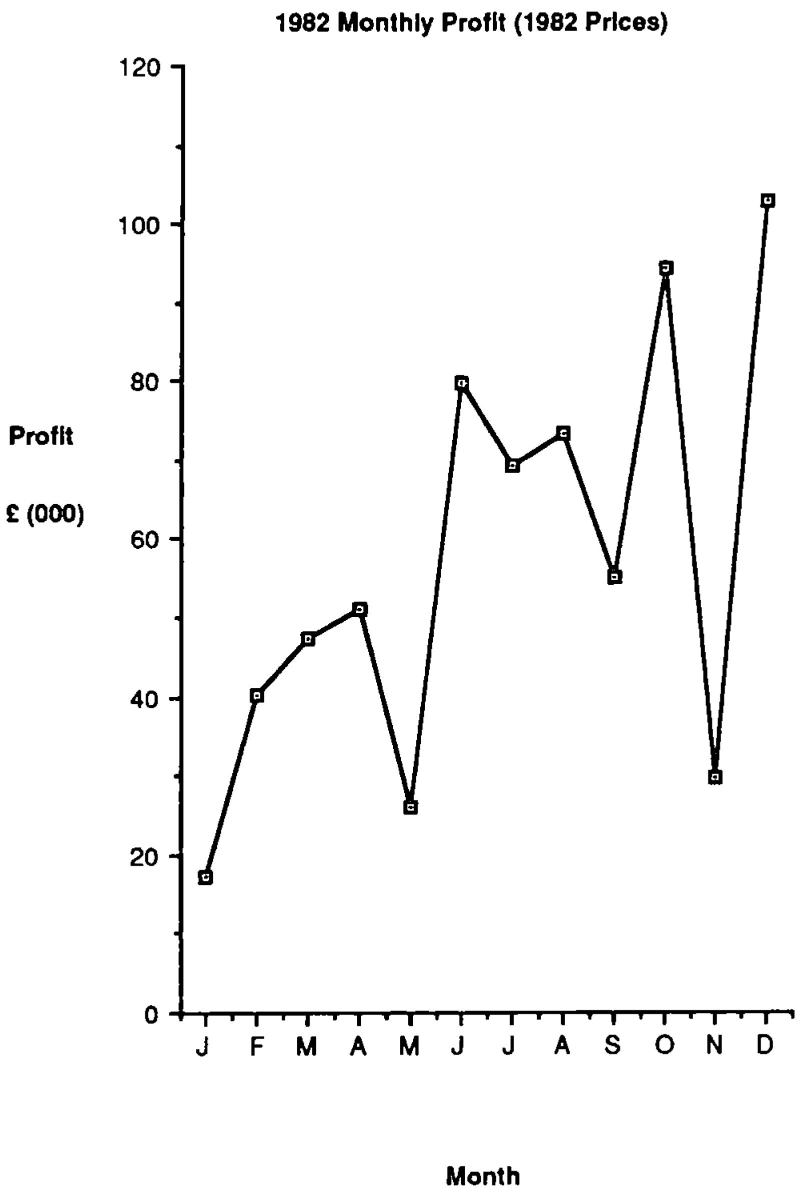

1982 Monthly Profit (1982 Prices)
Profit
£ (000)
120
100
80
60
40
20
0
J
F
M
A
M
J
J
A
S
O
N
D
Month

Figure 5 shows that the year can be split into two; the period from January to May is characterised by relatively low levels of profits. In contrast, the period from June to December, with the exception of November, is characterised by much higher levels of profits. To emphasise this pattern, the average monthly profit for the first five months of the year is £36,367 compared to £72,094 for the last seven months up to December. This clearly shows that the bulk of the sector's profits occur in the second half of the year. This pattern is further supported by Figure 5 which demonstrates that not only are higher absolute levels of profit attained in the latter six months, but that profitability is higher with the profit per stone of demersal fish also being higher in the second half of the year. This higher unit profitability is obviously a major factor behind the higher absolute levels of profit recorded.

In providing an estimate of the 1982 financial position above, it is not possible to test the accuracy of the entire model against the actual level of profitability, as that is not known. However, above, the most accurate demersal model of demand has been used for forecasting the purchase price as discussed in Chapter 7. Some indication of the accuracy can be obtained by substituting the observed monthly purchase prices into the model and using these as the basis of a forecast. The results are shown below in Table 4 alongside the results obtained using the forecast purchase prices for comparison. Here it can be seen that both sets of prices produce similar estimates for profits. The aggregate total using the observed purchase price is slightly higher but still very much of the same magnitude as that produced by the forecast purchase prices. In addition, the seasonal pattern in profitability produced by the observed purchase prices is very similar to that produced by the forecast purchase price with the bulk of profits occurring in the latter half of the year. Some differences between the two sets of purchase prices do exist. In particular, the observed purchase prices produce markedly higher profit forecasts in the months of May, July and November. Conversely in April the forecast purchase price produces a considerably higher forecast of profit than that produced by the observed price. The differences that do appear between the two sets of estimates are the result of errors in the demersal model of demand, and are also exacerbated when the purchase prices are reflated from 1978 to 1982 prices. Nevertheless, the differences between these two aspects of the model are not very great, and in general confirm the accuracy of the demersal model of demand in forecasting monthly purchase prices.

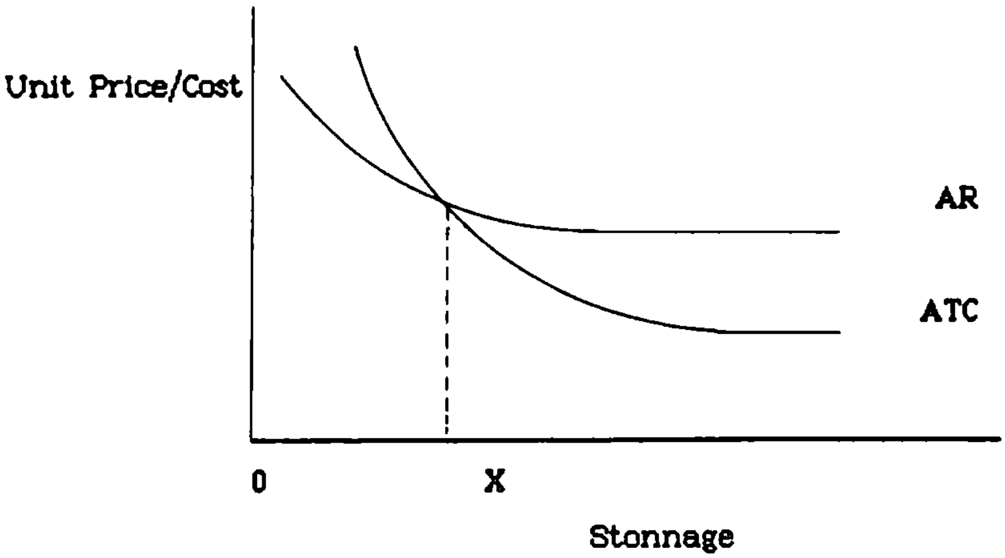
Table 4 : Monthly Estimates of Profits based upon Observed and Forecast Purchase Prices

Month	Observed Purchase Price (£)	Forecast Purchase Price (£)
J	11,138	17,103
F	46,004	40,172
M	64,248	47,278
A	27,370	51,209
M	29,515	26,072
J	89,375	79,803
J	90,482	69,136
A	79,564	73,431
S	53,002	55,267
O	88,296	94,393
N	41,664	28,891
D	99,333	102,736
Total	720,411	686,491

Before moving on to discuss the major features of the model and their implications in more detail, it is useful to consider some additional information which can be gleaned from the application of the model to 1982 supply levels.

The model in 1982 shows the sector making a profit in each month. However, an important question with wide managerial implications is, at what levels of supply for each month would the port merchant sector be making a forecast loss? One can in fact use the relationships in the model to derive a form of breakeven analysis for each month of 1982.[1] For a range of quantities, one can derive unit cost and revenue structures for each month of the general form below in Figure 6 :

Figure 6 : **Monthly Breakeven Analysis**



where : AR = Average Revenue

ATC = Average Total Cost

X = Breakeven Quantity

---

1. This could be undertaken for any month of any year once inflation had been taken into account, and could accompany any future forecasts.

The average revenue curve is simply the selling price at different levels of supply. In other words, the demand curve facing the port merchant sector in the marketplace. This is derived by using the demersal demand model and the pricing model to estimate selling prices. The average total cost curve is the forecast purchase price plus unit fixed and variable costs for different levels of supply. At some quantity, the cost curve falls below the revenue curve reflecting the spreading of fixed costs over successively larger quantities. For each month of 1982, a breakeven graph of the form in Figure 5 has been produced and these can be found in Appendix 5. A summary of the findings is reproduced below in Table 5 :

Table 5 : **Breakeven Analysis for 1982**

Month	Breakeven Quantity (Stores)	Actual Quantity (Stores)
J	84,000	108,701
F	104,000	176,039
M	78,000	144,271
A	92,000	178,904
M	96,000	141,244
J	92,000	227,215
J	90,000	209,963
A	78,000	179,741
S	72,000	136,765
O	56,000	137,390
N	70,000	100,193
D	60,000	169,091

The reason for the variation in breakeven quantities from month to month is due to the different seasonal coefficients in the demersal forecasting model. Months with high demand coefficients, such as October and December, have lower breakeven points and months such as February with low coefficients have high breakeven points. This effect is attributable to high monthly coefficients raising the purchase price comparatively more than in low demand months irrespective of quantity. For example, in October the purchase price at a quantity of 100,000 stone would be approximately £9.85 per stone. For a low demand month such as February, the forecast purchase price at 100,000 stone would be £6.85 pence per stone. This effect is due to differing seasonal coefficients. At a constant quantity of say 100,000 stone, the fixed and variable costs would be the same in the above months at that quantity, but the application of the constant percentage spread pricing model will raise a higher purchase price proportionately more than a low one when estimating the selling price. The effect of this is that for October the revenue curve is higher above the cost curve than it is for February. The result, therefore, is that in months where demand is high in the model, the breakeven point moves over to the left of the graph, thus meaning that the quantity of fish needed by the port merchant sector to make a profit is lower in high demand months than it is in low demand months.

Table 3 quite clearly shows that for most months, the port merchant sector is operating well beyond the various breakeven points. The only exceptions are January, November and to a lesser extent May. The implications of this breakeven analysis will be discussed more fully in the next section, but at this stage one should emphasise that we now have a method which is capable of determining in quantitative terms the minimum levels of monthly demersal supply needed for the port merchant sector to maintain its profitability.

CHAPTER 9

CONCLUSIONS: IMPLICATIONS, APPLICATIONS AND RECOMMENDATIONS

9.1 Introduction

At the end of the previous chapter, the various components of the model of port merchant operation were brought together to illustrate how the model functions in a forecasting context by providing a more detailed and disaggregated view of the financial performance of the port merchant sector in 1982. In addition, a series of breakeven graphs have been derived from the model relationships which relate monthly cost and revenue functions to profitability and supply levels.

The fact that this has been achieved is in fact significant, as it represents the attainment of the principal objective of this thesis. That is, the development of a model which can forecast and explain the effects of a variety of external changes upon the financial performance and profitability of the distribution system for fresh demersal fish in the South West.

This chapter draws together the various components of the thesis developed so far and makes conclusions about the major implications and applications of the model as it has been developed. Section 9.2 follows on from the model's development and discusses its implications and use in the South West in terms of forecasting the major influences on the profitability of the port merchant sector. Section 9.3 summarises the thesis and discusses the main achievements in a wider context. Section 9.4 follows from this and evaluates the principles of the model as the basis of a variety of applications in a managerial context. Section 9.5 develops this and indicates likely fruitful future directions of research.

9.2 Model Uses and Implications

As a beginning to this section, it is useful to begin with a summary of the main features of the model. It was identified in Chapter 5 that in order to develop a model with the ability to forecast and explain the effects of supply variation on the performance of the port merchant sector, three major relationships had to be estimated or derived. Firstly, a method had to be developed to explain movements in the purchase price of demersal fish, the major cost to the port merchant sector. Secondly, a model which described the cost of performing functions by port merchants needed to be derived. Finally, a model describing the pricing behaviour of port merchants was needed.

In the first case, traditional economic theory of demand was used to develop an econometric equation which related the purchase price of demersal fish to quantity, a time trend and monthly seasonal demand variables. The importance of this equation is that supply, and its variation, forms an integral part in explaining movements in purchase prices in the manner suggested by economic theory. The following logarithmic demersal model of demand was successfully estimated :

$$\begin{aligned}\text{Log } P = e\ & 3.62 - 0.194 \text{ Log } Q + 0.046 \text{ Log } t - 0.09F + 0.024M - \\ & 0.057A - 0.079M - 0.059J - 0.043J + 0.025A + 0.069S + \\ & 0.226O + 0.064N + 0.133D\end{aligned}$$

Estimated on January 1978 data.

(1)

where:

Log P = monthly average price of demersal species.

Log Q = monthly quantity of demersal species (stones)

Log t = time trend.

F - D = monthly seasonal variables

The cost model of performing functions was developed from the sample data and then upgraded to represent the port merchant sector located at Plymouth, Newlyn and Brixham. The model takes the following form:

$$CF = £88,336 + 0.46Q \qquad (2)$$

where :

CF = monthly cost of performing wholesale functions.

£88,336 = monthly level of fixed costs

0.46 = monthly unit variable cost co-efficient.

Q = monthly quantity of demersal species.

The model of pricing behaviour was developed from the sample data in a similar fashion to the cost model and takes the following form:

$$SP = 0.2375PP + PP \qquad (3)$$

where:

SP = selling price per stone.

PP = purchase price per stone.

When the model is put together, it can be used to provide an estimate of profitability for the whole port merchant sector based upon demersal fish, as seen for 1982 in the previous chapter.

The structure of the model quite clearly shows the major factors which determine the profitability of the port merchant sector operating together: the level of supply, seasonal demand, and costs. Not only does the model allow one to discuss the implications of these determinants, but one can use the model to forecast and analyse the impacts of changes in these parameters on the profitability of the sector, and to show how sensitive the sector is to changes in these variables and parameters.

9.2.1 Changes in the level of supply

Of the factors influencing profitability, supply is the most important. The view taken in this thesis, is that supply variation is an essential characteristic of the fresh fish distribution system. In addition, it is exogenous in that it is determined principally by factors on the fishing grounds and not by the port merchants. The causality in the demersal demand model is that merchant demand, reflected in purchase prices, adjusts to the available supply. The level of supply is ultimately the major factor determining the cost of fish through the price flexibility of demand. Higher levels of supply result in lower purchase prices and vice versa. Increases in supply increase profits in two main ways. Firstly, as seen in the breakeven analysis, once the breakeven point is passed unit profitability increases as unit fixed costs fall with increasing supply. However, this spreading of fixed costs does not indefinitely result in increasing profit per scale. After certain scales have been reached unit fixed costs decline by very small amounts with increasing quantity. Nevertheless, increases in quantity will still result in higher absolute profit levels as scale increases.

In order to give some idea of the effects of changing levels of supply on profits, one can use the model when applied to 1982 data to show what profits would have been in each month holding everything else in the demand model constant and just using 1982 supply levels. Table 1 below shows the whole model forecast of profits and the supply levels for comparison :

Month	Forecast Profit based on the Whole Model	Forecast Profit based on constant demand	Monthly Supply (Stones)
J	17,103	17,103	108,701
F	40,172	59,383	176,039
M	47,278	42,491	144,271
A	51,209	64,286	178,904
M	26,072	42,541	141,244
J	79,803	93,151	227,215
J	69,136	83,497	209,963
A	73,431	66,545	179,741
S	55,267	40,394	136,765
O	94,393	42,730	137,390
N	29,891	19,296	100,193
D	102,736	67,608	169,091

Table 1 The Effects of Changing Supply Levels on 1982 Profit Forecasts

In Table 1, the variation in profits caused by different supply levels alone can be seen by holding seasonal demand co-efficients constant at January levels. The table clearly shows the higher the supply, the higher the absolute levels of profit. The table also shows that at higher supply levels, unit profitability increases due to a greater spreading of fixed costs. For example, a comparison of January and June reveals this effect. Supply in June is 209% of the January level, yet profits in June are 545% of the January level. Unit profitability in January, based on the constant demand forecast is 15.7 pence per stone compared to 4.1 pence in June.

The procedure for forecasting the effects of changing levels of supply is relatively straightforward, although in reality one would use the whole model rather than the partial analysis conducted above. The model parameters have been estimated over a sample of data which included a large range. In forecasting the effects of supply change, one should be restricted to forecasting within the range of the sample, as for other samples outside the range, different model co-efficients might be found. Therefore, providing this condition is met, one substitutes a monthly quantity into the equation and follows the procedures adopted in the last chapter when an estimate for 1982 was derived. The model will provide an estimate for the unit purchase price at January 1978 price levels. The cost model is in 1982 terms. Therefore in forecasting into the future, some adjustments for inflation will be necessary to arrive at nominal estimates.

9.2.2 Changes in Seasonal Co-efficients

In the original model specification, it was felt that the major variable influencing the purchase price of demersal species was supply alone. However, as the model developed, it was realised that the phenomenon of seasonality was so important that it had to be specifically included as an explanatory influence in the model of demand. As a result, a series of monthly demand shifting variables were included in the model of demand.

Not only was it found that monthly purchase prices exhibited considerable seasonal variation in the results, but that this seasonality also forms an important influence on profits when the whole model is used for forecasting. The way this works was discussed briefly in the last chapter. High seasonal demand co-efficients result in high unit prices in certain months. When the constant percentage spread pricing model is applied, this results in high average revenue curves for those months when seasonal co-efficients are high and vice versa. In those months when seasonal co-efficients are high, the gap between the revenue and cost curves is more than in months when they are low.

One cannot get an appreciation of this seasonal demand effect in the forecast as supply varies as well. However, if one adopts the same procedure as earlier and adopts a partial analysis, one can gauge the magnitude of this effect. Table 2 below shows the unit profitability for 1982 based upon a monthly quantity of 100,000 stone and the different estimated seasonal co-efficients for each month :

Month	**Unit Profitability based upon 100,000 stone (pence)**
J	10.7
F	-2.2
M	16.6
A	4.5
M	2.6
J	4.2
J	6.0
A	17.8
S	26.3
O	55.5
N	29.8
D	41.1

Table 2 **The Effects of Seasonality upon Profitability**

The different figures above for each month correspond exactly to the magnitude of the seasonal variables in the demersal model of demand. October and December have by far the largest estimated seasonal co-efficients in the model and these are reflected above.

Given the importance of these seasonal influences, it would be possible to use them in a forecasting context not just as they stand, but by changing their magnitude to indicate the likely impact upon profitability. However, to do this, one would need to be specific as to the source of the change in seasonal demand. This will be discussed further later in the chapter.

9.2.3 Changes in Costs

The final major influence upon profitability is the cost function, comprised of fixed and variable elements. The shape of the average total cost curve indicating lower unit costs which fall at a rate faster than for selling prices based upon higher supply levels. Unlike the effects of supply and seasonality, the fixed cost element of the model is constant, although the variable costs rise in a linear fashion with output.

One could examine the impact upon profitability of different cost structures by developing new models or changing the parameters of the existing model. Again, to provide a realistic forecast in this context, the change in the cost model should reflect realism rather than be based upon hypothetical speculation.

In the above discussion, the model has been used in a partial manner to isolate the effects of the major influences on the sector's profitability. In the forecast for 1982 in the last chapter, the influences are acting together. In order to show the effects of changes in supply on profitability and the combined effect of seasonality, the model when applied to 1981 supply levels reveals a very difference situation to that in 1982. Table 3 below shows the results when this is undertaken :

	1981		1982	
Month	Profit (1)	Supply (Stone)	Profit (£) (2)	Supply (Stone)
J	35,047	165,881	17,103	108,701
F	- 4,281	107,280	40,172	176,039
M	- 14,625	78,971	47,278	144,271
A	7,282	117,076	51,209	178,904
M	13,312	115,937	26,072	141,244
J	17,385	125,767	79,803	227,215
J	38,857	166,978	69,136	209,963
A	37,754	173,370	73,431	179,741
S	66,586	146,686	55,267	136,765
O	84,360	118,364	94,393	137,390
N	67,258	142,163	29,891	100,193
D	33,630	104,801	102,836	169,091
Total	380,565	1,564,174	686,491	1,909,517

Table 3 : **1981 and 1982 Monthly Profit Forecasts and Supply Levels**

(1) Profit expressed in 1981 terms

(2) Profit expressed in 1982 terms

The above table illustrates several important points concerning the determinants of profitability. Not only does the model forecast lower levels of profits for 1981, but actually forecasts losses in February and March of 1981. These losses and the generally lower levels of profits can be attributed to a combination of lower supplies particularly occurring in months where seasonal co-efficients are relatively low. This can be seen in the early months of 1981. The vast bulk of forecast profits in 1981 occur in the latter part of the year when seasonal co-efficients are also higher. Lower levels of supply can to some extent be located in the latter part of the year as higher seasonal variables pull up unit profitability. The model shows that the worst situation for the port merchant sector is to experience low levels of supply in months with low seasonal co-efficients. Conversely, the optimum situation is to experience high supply in high seasonal demand months as it is then that profits will be at their highest, resulting from lower unit fixed costs and higher net margins due to season.

To end this section, it is useful to summarise the major points in diagrammatic form. Figures 1-3 below show the major situations facing the port merchant sector and in particular demonstrate how the major changes which the model can forecast the impact of, would affect the profitability of the sector (in this case the changes are ways in which profits are increased, the opposite could just as easily be illustrated) :

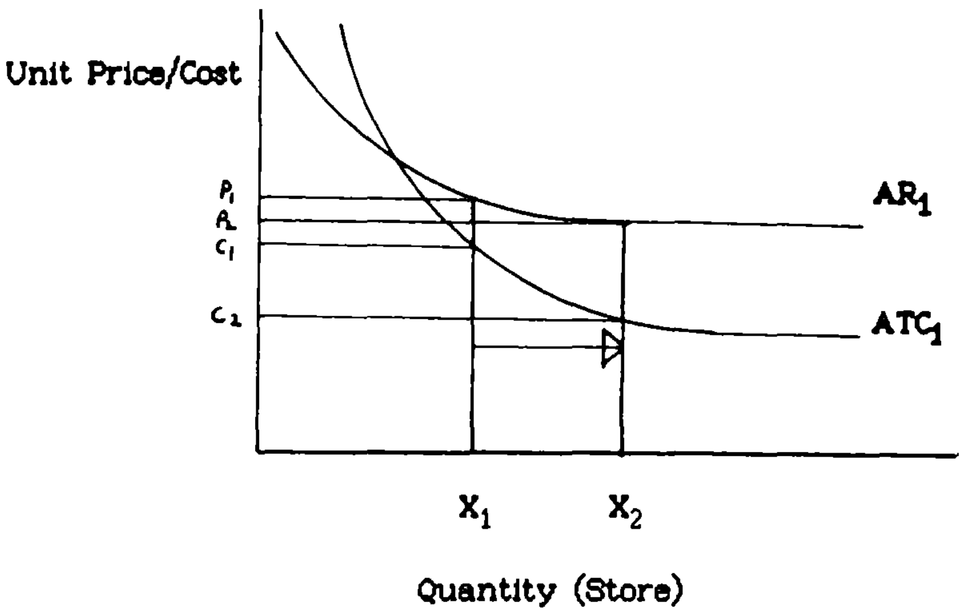


Figure 1 : **An Increase in Quantity**

In the above case an increase in quantity leads to greater absolute levels of profit and higher unit profitability due to lower unit fixed costs.

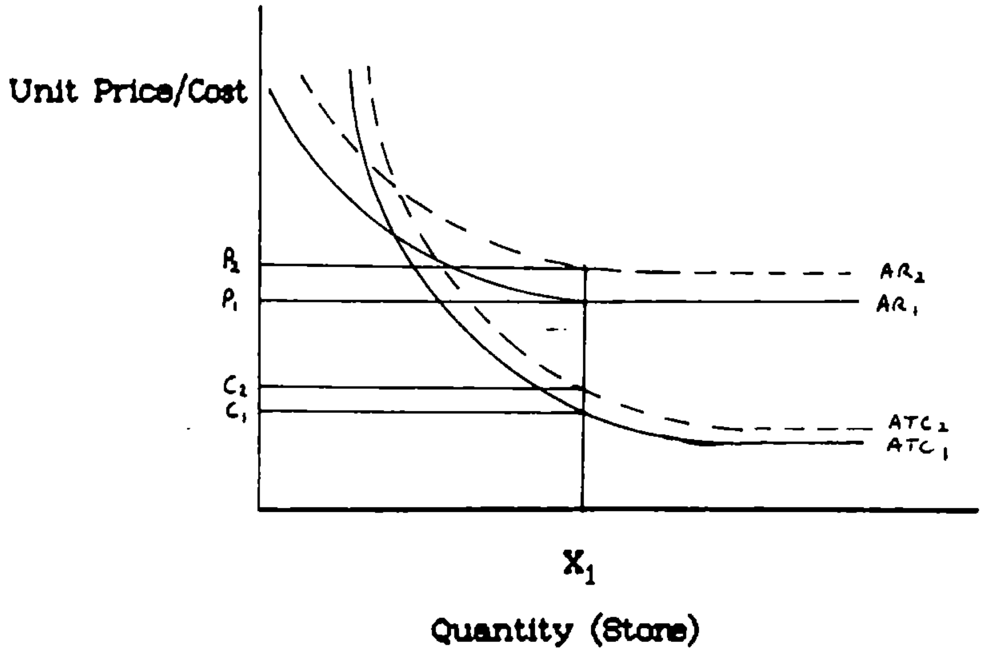


Figure 2 : **An Increase in Demand**.

In this case both the AR and the ATC curves rise, but the former by more than the latter resulting in increased unit profitability.

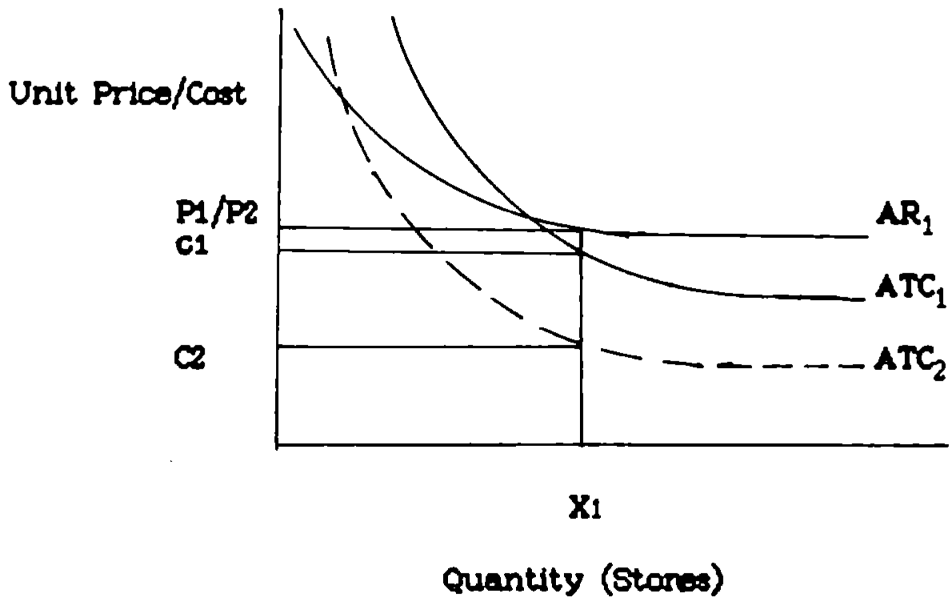


Figure 3 : **A Fall in Costs**

In this case, selling price remains the same, but unit costs fall leading to increased unit profitability.

9.3 Thesis Summary and Achievement

In the introduction to this thesis, it was established that within the growing interest in the marketing of fresh fish in the United Kingdom there was a distinct lack of knowledge and understanding about the distribution system by which fresh fish passed from production to consumption. Several areas of concern where understanding was missing were discussed: the institutions in the system, their importance and functioning: the efficiency of the system : and what had been the effects of the changing fisheries environment upon the system. These areas of concern had led to calls from those interested in the fishing industry for some kind of investigation into the distribution system for fresh fish in the United Kingdom.

It was established that this thesis was an attempt to answer such calls and provide a fuller understanding of fresh fish distribution systems than had hitherto been attained. Two major aims to this end were identified: firstly, to identify the distribution system for fresh fish using the South West of England as a data base: secondly, to develop a quantitative model of that system with the ability to forecast and explain the effects of external changes upon it.

The completion of the previous section marked the attainment of these aims, and the stage has now been reached where the thesis can be summarised and its achievements evaluated.

The starting point for this thesis in Chapter 2 was a review of the marketing and distribution literature. The aim here was to take a wider view and determine whether any successful analytical or theoretical models or frameworks had been developed in the general literature which could form the basis of an explanatory and forecasting model of the South West distribution system for fresh fish. A review of this literature revealed that the areas of efficiency in distribution systems and responses to and the effects of change were regarded as central areas of study. However, much of the literature was concerned with the organisational, micro, level and was managerial in nature. In other words, how to manage an organisation's position in a distribution system or channel and how to respond to and manage change. Comparatively few works were discovered which took a macro view of marketing and distribution systems. Many of these which did were often descriptive, attempting little analysis or meaningful evaluation. Many of the theoretical works were often concerned with conceptualising about distribution systems in various ways and classifying them according to institutions, structure and function.

The one exception to this general rule was the work of L.P. Bucklin. He attempted to develop some of the conceptual work which had gone before, and put forward a theoretical general cost performance model of distribution system operation relating demand for system output to structure. Bucklin hoped that his model would provide a framework within which one could study real world systems, including efficiency and the effects of change. However, for a considerable number of reasons, his complex general model was rejected as the basis of a model of the distribution system for fresh fish in the South West.

In Chapter 3, attention was turned to the distribution system in the fishing industry. Several studies and reports were reviewed in which problems in the marketing of fresh fish had been identified, causes put forward and recommendations made. It was in these works that the principal concerns over the lack of understanding of the distribution systems were voiced. Chapter 3 also discussed the major characteristics of the distribution system in the United Kingdom in a qualitative sense. The existing literature suggested that the dominant method of distribution was via the auction, port merchants, inland wholesale merchants and a variety of fish retailers. The unique structure of this system was attributed to a variety of determinants: perishability of fish; a lack of standardisation; and most importantly the problem and major characteristic of supply variation. This latter phenomenon, often alleged to be a major cause of problems in fresh fish consumption, is all the more unique, as the distribution system has little influence over supply.

In response, Chapter 4 reviewed critically United Kingdom studies of the fish distribution system, in order to determine the level of understanding. In general it was found that few studies went beyond a description of different facets of the system. Some authors, notably P.J. Rosson (1975) attempted to evaluate the efficiency of the system and the changes seen in the system, but were generally frustrated in their aims due to data problems and a lack of acceptable methodologies. A review of overseas studies of fish distribution systems revealed a similar picture, although to be fair, the emphasis in these studies was more analytical than descriptive. Several studies attempted to use a variety of modelling frameworks to analyse problems, although some were fraught with difficulties and others were concerned with investigating past problems. A general conclusion from a review of studies of fish distribution systems is that little is understood about such systems, particularly in the United Kingdom. In addition, little success had been achieved in developing models or frameworks which were able to study the key distribution system questions of efficiency and effects of change.

Having established that no acceptable models had been developed in the marketing literature, and that much of the fish distribution literature was descriptive, with few successful attempts at evaluating system efficiency and change, a model had to be developed in the thesis with these characteristics, and the ability to be used as a forecasting method.

The next stage was to develop a quantitative view of the system, for this, the system operating in the South West of England (Devon and Cornwall) was selected as a data base. Chapter 5 discussed the processes involved in identifying in quantitative terms the system. The results of the sample survey were presented, and when allied to landings data a quantitative identification of the system was achieved. The results show the importance of the three ports of Plymouth, Newlyn and Brixham within the region as sources of supply. The major routes of direct landings and the auction system were identified and the importance of the port merchants as recipients of first hand sales in the system. The operations of port merchants were identified along with a representative cost structure of their activities. Finally, the sample allowed for the quantitative identification of the different channels of distribution operated by the port merchants.

Once this stage had been reached, important decisions had to be made in two major areas. Firstly, what was to be the main objective of the model of be developed; and secondly, what aspects of the identified distribution system needed to be developed in a model form? Chapter 5 determined that the primary feature of the system was variability in the supply of the raw material, fish. Not only was it a main feature, but with the advent of Total Allowable Catches and the Quota System for major demersal species, it was likely to be the most important factor determining the success and financial performance of the fresh fish distribution system in the South West, and in the United Kingdom as a whole. This was felt to be especially the case given the exogeneity of supply and the increasing degree of external control over which the distribution system had little influence. It was, therefore, established that the model of the distribution system in the South West should have as its primary aim the ability to explain and forecast the effects of supply variation upon that system.

In terms of what was to form the basis of the model, it was decided that the activities of the port merchant level of the system should be the central focus. Not only is this the most important institutional level, but the aspect of the system who bears the brunt of supply variation. It was also decided that the model would concentrate solely on demersal species, and be based upon port merchants located at Plymouth, Newlyn and Brixham.

To determine the form of the model, three basic sets of relationships were identified as necessary components of a model of the effects of supply variation upon the port merchant sector. Firstly, a way of relating variable supply to the costs incurred by the port merchant sector. It was found that the theory of demand and supply would form the foundation of this aspect of the model. It was hypothesised that a series of demand and supply relationships would exist at the auction; reflecting available supply and port merchant demand. The demand of the port merchant sector would be reflected in purchase prices paid, which would also be the major unit cost to the system. The determinants of a relationship between supply and the costs incurred by the port merchants would represent the first stage of the model's development.

The second major aspect of the port merchant sector to be explained was a model which related the costs of performing wholesaling functions to the level of supply of the sector. In conjunction with the demand model, one would then have a method of relating system costs to supply.

Finally, Chapter 5 discussed the need for a model of price determination to allow for the determination of revenues. A model which forecasts prices in conjunction with a model which forecasts costs related to supply would in fact form a complete model of the port merchant sector where the effects of supply variation upon financial performance could be observed, explained and forecast.

Chapter 6 began the model development by evaluating econometric methods of estimating demand functions. After discussing the need for a supply equation due to its exogeneity and therefore inelasticity, it was argued that a single equation model of demand relating purchase prices to quantity was a valid specification of the situation facing the port merchant sector. After the data series was discussed, it was found that seasonality was an important factor and should be included. A new monthly specification of the model to be estimated was therefore put forward. The model was also specified for major individual species as well as for the demersal total.

Chapter 7 presented the results of the estimation of the demand model. After statistical procedures had been adopted to correct for the prescence of autocorrelation; the models were found to perform well. The individual species models serving to confirm the accuracy of the demersal model of demand. Forecasting exercises were also undertaken, further confirming the accuracy of the models as a basis for forecasting the purchase price of demersal fish.

Chapter 8 discussed the development of the cost and pricing model, and how both were developed from the sample data. Both models are based upon a number of assumptions which are held to be valid. At the end of the chapter, the entire model was put together in providing a forecast for 1982, for the whole demersal port merchant sector at Plymouth, Newlyn and Brixham. The model showed the sector in profit for each month and generally operating well past breakeven, although there is considerable variation in both due to season. The beginning of this chapter looked at the situation in more detail and explained how the model can be used to demonstrate and forecast the major influences upon profitability.

The first point to be made in assessing the achievement of the thesis is to state that the original aims have been reached successfully. One moved past the qualitative and provided a quantitative picture of the system operating in the South West. In itself, this is important; as it provides knowledge and understanding about the system which did not previously exist. More importantly, it provided a basis from which one could move from the descriptive towards the development of the analytical model.

The three individual components which form the basis of the model represent an achievement in a variety of ways. The number of demand models were successfully estimated and more detailed that previous attempts being based on monthly data. In addition, the usual procedure of deseasonalising the data was not carried out with the result that the models contain important seasonal variables often omitted in the past. The cost and pricing models go further than existing studies (e.g. Price Commission, 1976) in that they do not just present sample data, but actively use the data to develop models of the cost and pricing behaviour of the port merchant sector.

The model in its completed form provides a deeper insight into the situation facing the port merchant sector than could previously have been obtained. An important facet of the model is its realism, especially in the causality of its relationships. It protrays the port merchant sector as having very little control or influence over its own destiny. Supply and seasonality are major influences which are regarded as predetermined, especially in the short term. This tallies very much with the view of authoritative writers such as Taylor (1959) and against the view of works such as the marketing of fish (M.A.F.F. 1981a) who seem to suggest that problems in fresh fish marketing are in part caused by institutions in the distribution system in a variety of ways and could easily be rectified. In reality, certainly in the port merchant sector, the distribution system is shown to be a competitive system adapting to market conditions and exogenous influences which are largely outside its control. The relationships in the model reflect this situation.

Apart from calibrating the relationships in the sector, the model provides a basis for forecasting into the future, subject to the usual assumption that model parameters and assumptions remain unchanged in the future. One can even adjust the parameters to see what would happen if they did change, as discussed earlier. The model provides a basis for forecasting changes in supply, changes in seasonality and demand through adjusting model parameters and changes in costs in the same way. It should be emphasised that the incorporation of seasonality is especially important. It is an essential characteristic of fisheries and is included in the model as a major influence upon profitability.

Following on from this, the level of temporal disaggregation of the model is in itself a facet of importance. Monthly estimates for the port merchant sector are more useful than say annual estimates as they allow particularly good or bad months to be identified. From the model 1982 estimates, one can see that while the sector is annually doing well, there is considerable variation from month to month. This is reflected in the variations in breakeven points for the sector.

Another feature deserving mention, is that the model is an aggregated model of one level in the distribution system. It is not a model of part of the port merchant sector, but all of it based on landings made in the region. Therefore, if we were to use the model, then one would be analysing the effects upon the whole sector; an important factor when the model is used for decision-making purposes.

One should also note that the model itself is a relatively simple construct, which is not over-reliant upon vast amounts of data. One of the problems encountered by previous authors interested in fish distribution systems, particularly in the United Kingdom, has been the lack of consistent data, especially between production and consumption. However, this need not be a barrier to meaningful study as this thesis has shown. Certainly data could be more complete in many places, but careful selection of quantity and price data, and accurate sample data which does not need to be exhaustingly extensive, has allowed an analytical piece of work to progress to completion.

Perhaps the most notable achievement of this thesis, is that the model has an extremely large number of actual and possible applications as a planning tool. This is particularly important given the many increasing pressures upon fisheries in general and therefore fish distribution systems. Given the increasing scale of regulation and decision-making at regional, national and European levels, it is imperative that the impacts of decisions at these levels are considered, not just for the catching sector, but also for the distribution system. The next section examines a range of actual applications of the model as a planning method or tool.

9.4 Applications as a Planning Model

Several important points need to be made at the outset of this section, and which ought to be borne in mind throughout.

Firstly, the model and its relationships have been estimated for the fresh fish distribution system in the South West. Accordingly, any forecasting attempted with this particular model should only be undertaken for the port merchant sector in the South West. However, this does not mean that the model's use is exclusively confined to this area. It is a general model, the principles of which one would expect to find in other distribution systems for fresh fish. As such, there is no reason why a model based on these principles should not be developed elsewhere. This could be undertaken for other parts of the United Kingdom, Europe or in fact anywhere where the necessary conditions and data exist. This is an important point, as it means that such a model could then be developed and used by a wide range of bodies to fit particular circumstances. Examples of such bodies would be the Sea Fish Industry Authority, the Ministry of Agriculture, Fisheries and Food, the E.E.C. and even perhaps the Food and Agriculture Organisation of the United Nations. The range of applications in this section possess the general applicability and demonstrate the value of the model and its principles as a basis for providing improved information into decision-making at a number of levels.

In addition, while the majority of applications discussed here are at the industry/sectoral level, there is no reason why the model should not be used in a variety of ways for providing information at the company/organisational level. Applications at this level are also discussed.

Finally, the range of applications discussed here relate to how the present model could be used in its existing form, and how the principles of the model could be used as the basis of other applications elsewhere and in the South West. Where major new developments would be needed for the model to be used, then these will be discussed in the final section dealing with further research in more detail.

The great strength of the model in its variety of applications, lies in its ability to forecast the effects of changes in supply, seasonal demand and costs. The reason for its wide applicability in practice and principle is that these three influences conceal many different factors, changes in which manifest themselves as changes in these three exogenous influences.

The most obvious general application of the model lies in its ability to forecast monthly breakeven levels of supply, as well as profits/losses at different levels of supply. However, within this there are a number of specific sources of supply variation to which the model can be applied.

One of these is the impact of quotas upon the global demersal profitability of the port merchant sector. For example, in the South West, important demersal species such as Dover Sole, Monkfish, Hake and Plaice have been under increasing regulatory control with the setting of quotas. These species are critical to the success of the catching sector and the distribution system in Devon and Cornwall. For example, in 1982, these four species formed 29% of total demersal supply by weight and 54% by value. The setting of smaller quotas and changes in measurement of landed weight, such as regarding the monkfish tail as a whole fish and multiplying the tail weight by three, would result in decreased profits for the port merchant sector as total supply of these species would be reduced. If the model had been estimated for one year (say 1982), then if one had knowledge of the likely supply reduction in the next year, then the model could be used to analyse the impact of reduced quotas[1] upon global demersal profitability subject to the assumption that supply of other demersal species remained constant. This does not necessarily preclude however changes in the level of supply of other species in the forecast, rather if one wanted to look solely at the quota impact, this would be a sensible procedure.

The model's application to the effect of quotas could also be extended to a slightly different form of quota management assuming importance in the South West. Recently, Dover Sole quotas have been managed on a short term two monthly basis. If quotas have been used up before the end of the month, then fishing for the species has been suspended, resulting in very little fishing for or supply of the species for periods of up to two weeks. Again the principles above can be used to model this effect upon demersal profitability.

Developed from this capability of the model is the principle that the model can not only be used to look at the effects of actual quotas set, but can also be used to examine the effects of different quota changes. Throughout the range of applications, one can hypothesise about possible changes as well as examining the effects of actual changes.

---

1. If quotas were set on an annual basis, then to provide a proper monthly forecast the fall in supply would need to be apportioned to different months. A logical procedure would be to allocate supply reductions to months according to the importance of the landings of particular species in different months.

While reduced quotas of important demersal species will reduce profits and move the level of port merchant sector operation closer to breakeven, this may well not be the only way such a change would affect the sector. It was mentioned earlier that the aforementioned species formed a much larger proportion of demersal supply in value than volume terms. Thus one would expect that supply change is not the only impact upon profits. In fact, if the supply of high value species fell, then one would expect a change in the average value of demersal species. In the model, this is reflected as an influence upon profitability through the seasonal co-efficients. It was discussed in Chapter 7 that the seasonal variables in the demersal model had an extra dimension to those in the individual species models. Part of the seasonal variation in demand co-efficients could be attributed to a changing species mix from month to month. It was noted in the demersal model that high seasonal co-efficients tended to be associated with a higher procoportion of high unit value species in that month. The particular species in question are Dover Sole and Monkfish, two of the major species under quota control. Reductions in available supplies of these two species will tend to reduce seasonal co-efficients in the model, and therefore unit profitability in the manner discussed earlier. If one could establish the relationships between high unit value species as a proportion of total supply and seasonal co-efficients in the model, then there is no reason why the model should not be used to examine the twofold pressures of falling supply levels and an associated change in product mix away from high unit value species.

This last sentence reveals another important point. That is, the model reflects a number of influences, and therefore can be used to model simultaneously the effects of more than one change upon profits and profitability.

Thus far, it has been indicated how the model could be used to model what are essentially negative influences upon the port merchant sector. However, the model could equally be used to examine ways in which the sector could increase profits.

One of these ways is to increase the supply of fish to the system, although prospects for achieving this must be regarded as limited. It is a contention of this thesis that the port merchant sector could do little to raise supply levels, especially in the short term. To all intents, demersal supply is inelastic, and not determined by port merchant demand in the short term. Supply is ultimately determined by exogenous factors on the fishing grounds such as technology, biological characteristics of fish stocks, the weather and more recently external control and regulation. Any control the onshore sector could exert over supply levels would be long term and probably indirect through the changing of demand patterns acting as long term signals to fishermen. Such a longer term response would do little to alleviate short term or sustained short term loss situations. Even if we dropped the inelastic supply assumption and fishermen received the price signals in the short term to increase supply, it is doubtful whether they would be able. It is unlikely that the heavily exploited nature of many stocks would allow for increased supply. The fact that supply shortages are seen to be the major cause of falling profits is testament to the fact that in many cases increased supply is not a viable alternative.

This does not mean that no action can be taken on the supply side to aid the sector in both the short and the longer term, there are instances where supply can be increased and the model used to analyse the effects.

One solution to the supply shortage problem stems directly from the benefits of a co-operative marketing and catching structure. The co-operative based at Brixham does not concentrate fishing effort at extra cost on species such as Dover Sole which are heavily exploited in South West waters; the co-operative argreement between merchants and fishermen has led fishermen to fish further afield for such species as Dover Sole, particularly in the Liverpool Bay area. Fish is then landed in the Liverpool area and transported back to Brixham. Presumably, this development has increased supply and while incurring greater variable costs has allowed a greater spreading of fixed costs and pushed the co-operative's level of operation further to the right of breakeven. While it is uncertain how great opportunities of this type are or are likely to be, the model can provide a framework for assessing the desirability of such projects and thus at the same time demonstrate the procuring benefits of a co-operative structure. Providing one had some indication of the increased supply of fish likely to come from such a venture, the change in species mix and the likely change in variable costs, then the model could provide a method for determining the desirability of such extra effort and even providing a method for choosing between alternative sources of extra supply with relative differences in supply levels and associated transport costs. In fact, the last point can be developed to say that in principle, the model provides a basis for evaluating the benefits likely to accrue from new fishing grounds in terms of relative profitability.

The applications discussed thus far have concentrated on how the model can be applied to the effects of changes on the supply side, only mentioning the supply species mix effect upon seasonal demand co-efficients. However, the seasonal co-efficients provide the basis for a further range of applications.

One of the most important of these is that the model provides a way of managing fish stocks more efficiently taking into account both demand and supply side characteristics. For example, as well as evaluating the impact of changes in quotas, the model can indicate at what times of the year available quotas would be most beneficial to the distribution system and also the fishermen. The foundation for this statement lies in the nature of the seasonal co-efficients and their meaning in the context of the model. In the demersal model, the monthly co-efficients indicate relative species mix, and different levels of demand for each month. This is shown more clearly in the individual models where high seasonal demand co-efficients have adjusted to months in which supplies are high. In the context of the individual models, these different seasonal co-efficients represent influences upon the purchase price of the species. The point is that they represent shifts in the demand curve, not supply induced movements along the demand curve. There are many possible determinants, for example, a good monthly supply, good quality, relative prices of substitutes, the holiday season or changes in pattern of consumption through the year. Regardless of the source of change, the result as discussed earlier is that high seasonal co-efficients cause high unit profitability. The model, therefore, suggests a way of managing fish stocks on a seasonal basis. In particular with quotas, the model suggests that available annual quotas should be biased towards months in which demand co-efficients are highest to increase sector profitability: in other words managed on a monthly basis. While the co-efficients in the individual models could be used for this as they follow the same pattern as the individual models, the same logic for seasonal co-efficients in the individual models should hold in that the higher they are the higher will be unit profitability. In the case of the Dover Sole model for example, this suggests that available quotas should be biased towards the latter half of the year. This is doubly sensible as this also happens to be the period of the year when the fish tend to be more available anyway, and this may well be one reason why demand is higher in these months as well. One important implication of the model's usage in this way is that if quotas for important species are being reduced, then the impact of this can be to some extent mitigated by concentrating remaining quotas into high unit profitability months. The model therefore demonstrates how a more efficient use can be made of available or even falling levels of supply on a seasonal basis. It should also be mentioned that not only does the merchanting sector benefit, but also the fishermen would be receiving higher prices in some months relative to others. If these months also happen to be months in which the fish is reasonably available and plentiful in the fishing grounds, then the fishermen will also need less nominal effort to harvest the fish resulting in lower unit costs.

To some extent, this type of operation is already occurring for Dover Sole in the South West. Quotas on a two monthly basis have been adjusted seasonally with larger quotas being available at those seasons when the fish is available. To what extent demand side characteristics have been incorporated is not clear, but the months with higher quotas are towards the end of the year when seasonal demand is high as shown in the Dover Sole model. As long as there is not great divergence between supply and demand seasonal peaks, this is clearly a more beneficial way of utilising a diminishing natural resource. One should add that the other individual models in Chapter 7 for Monkfish, Lemon Sole and Plaice do not demonstrate quite such a pattern. Seasonal supply peaks do not correspond as closely to demand peaks. the models show that some adjustment of supplies to those months with high co-efficients would be beneficial, with the obvious constraint of the species being available.

If one were to shift supplies into high season months, then there might be a problem, particularly within the model estimates for the South West. That is, supplies would be low in low demand months leaving the merchanting sector facing low levels of profits or even losses. How could the model be used to show increased profits in these months? Apart from increasing supply generally and concentrating supply into high demand months, a further alternative is to increase the demand curve facing the port merchants. The role of advertising the benefits of fresh fish has been suggested as one method of raising the demand curve for fresh fish (e.g. M.A.F.F., 1981a). The point they argue is that the fish consumer needs to develop a franchise with fresh fish which is not totally dominated by price; in other words stressing attributes of fresh fish which will make consumers purchase fresh fish even when prices are high compared to substitutes. In essence they are suggesting that successful advertising would decrease the price elasticity of fresh fish and/or increase the price paid for the same quantity, in other words to induce a shift upwards in the demand curve. In the context of the models estimated in this thesis then, with the inelastic supply assumption, this would be interpretated as an increase in the demand curve or an increase in the price flexibility of demand, either making consumers pay more for the same amount or pay proportionally more per unit as a result of a fall in supply.

The point is that the model can be applied to analyse the effects of advertising upon attempts to raise the demand hence profitability of the port merchant sector, as the demand facing port merchant sector is derived from the consumer ultimately.

One of the applications of the model is that it can be used to analyse attempts to adjust demand through advertising. If we had an indication of the changes in purchase prices either due to raising the price flexibility or through raising the demand curve, then we could analyse the impacts of advertising upon unit profitability. One of the particular uses of the model here is that it can be used to indicate in which months advertising should be concentrated, i.e. in those months when demand is low. It seems plausible to suggest that advertising is better concentrated in months when demand is low rather than high as the model shows.

Another possible use of the model is in the area of quality improvement. This has been suggested as a major problem in the fishing industry in terms of poor quality (M.A.F.F., 1981a), and suggestions have been made as to its improvement: although this study found little scope for this in the South West, with fresh fish being landed daily, well sorted and graded, well iced and distributed quickly. However, as a general principle, quality improvement would be reflected in increases in purchase prices caused by increased seasonal demand co-efficients. The model could be applied here to determine the net benefits of such improvements. In particular, the increases in profits compared with the increases in fixed and variable costs needed to undertake such improvement. The same principles could be applied to other changes such as value added through product development. The model could determine the impacts given increases in demand and costs.

Another problem which may well be faced with onshore merchanting operations at present elsewhere or in the future is that of months or periods of months when losses may accrue due to factors such as supply shortages which can seriously affect fixed onshore operations. It may be that due to local, regional or even political reasons, onshore operations might qualify for subsidies or grants to cover themselves during periods of short term problems. In principle, there is no reason why the model should not be used to indicate the magnitude of financial aid and also its timing, in terms of which months it is needed.

Other more radical uses of the model may arise due to similar problems. The merchanting sector is made up of a number of firms who are similar in many respects. It could arise for example that supply levels have fallen to uneconomic levels where some port merchants are not making profits at all due to unavailability of supplies or the whole sector is faced with reduced profitability. It may be that in this type of scenario that the most obvious solution would be to reduce the number of port merchants in the sector to allow increased profitability for the remainder. It is quite possible in such a scenario that all merchants would keep going in business in the hope of better times to come, when in reality the best solution is to reduce the number of merchants especially if the problems were longer term. If we had a model such as the one developed here, then it could be used to determine the amount of fixed cost needing to be removed from the system in order to return the sector to profitability if that was the case. Taken to a logical, if rather extreme, conclusion, the model could be a basis for some form of licensing system to cover the number of port merchants, to ensure that profitability is not dissipated in overall terms through too much fixed cost in the system, for the available levels of supply.

In the previous paragraphs the issue of costs has been brought into the picture. It should first be emphasised that the model does allow the analysis of changing cost functions facing port merchants. This is particularly important given the competitive price taking nature of the sector where increased costs will reduce unit profitability.

At this stage in this section, the applications of the model denote a change in emphasis away from forecasting the effects of various changes towards the broader use of the model in the realms of efficiency. It was noted at the beginning of the thesis that efficiency and the effects of change were the two most important topics for study in marketing and distribution systems and potentially major problems in the distribution system for fresh fish. It was decided that a model of the effects of change was more pertinent as the central role of the model. Efficiency as a concept, however, is implicit in the model as the various changes so far discussed have implications for the efficiency of the port merchant sector either in terms of changing unit profitability or changing unit costs. However, a central question remains: Is the port merchant sector efficient and can the model be used to say whether it is efficient or not? The answer to the first part of the question is, one cannot say in the way that economists and authors such as Bucklin would define the concept of efficiency. One does not know whether the system which has been modelled is offering optimum levels of output at minimum unit cost or not as one does not know how it is operating with regard to some optimum or other. Anyway, this was not the prime objective of the model developed. The answer to the second part of the question is yes, if one is prepared to adopt a different definition of efficiency which accurately reflects the position of the port merchant sector.

It has already been discussed earlier that there is evidence for efficiency in the conventional sense; port merchants use outside transport taking advantage of external economies of scale; they reduce risk by purchasing supplies from boats and the auction; also they further reduce risk by depending on a large number of distribution channels.

However, with regard to whether the port merchant sector is operating at the lowest point on the average total cost curve is largely irrelevant for two reasons. Firstly, one does not know whether the cost curves facing the sector are in fact the lowest or whether the minimum point on the existing curve has been passed. Secondly, the sector has virtually no control over supplies. Supplies which determine purchase prices, determine the major cost to the sector over which it has no control given the exogenous nature of supply and the price taking nature of the market.

What can one say however, is that the evidence from the South West model is that the sector is efficient as at 1982 levels of operation, the sector is operating well past breakeven on the flat part of the average total cost curve. This suggests that the sector is efficient in the face of a variable supply. The way in which it achieves this is through keeping fixed costs to a minimum and help keep the breakeven level of operation well to the left. To this end, the model as a general construct can be used as a test of efficiency between similar distribution systems by determining the relative levels of fixed costs. These systems with the lowest levels of fixed costs, one would deem more efficient. It follows logically that with such a major cost outside of immediate control, fresh fish distribution systems need to be efficient to stay in business.

Finally, in this section on applications, we turn to the company/organisational level. There is no reason why the principles of the model developed should not be applied at this level, although the model estimated is for the sector as a whole. For example, the purchase prices paid by individual merchants will bear close resemblance to those in the model. The purchase prices are determined by supply and demand where individual merchants are price takers not price makers. Thus prices paid by merchants at auction will be very similar, although on average might vary depending on the range of species purchased. In addition, there is no reason why the principles of the cost and pricing models should not be developed by individual firms or organisations for their own use. Individual models as well as the demersal model allied to a model of a particular organisation's cost and pricing structure could be used for a range of applications. Knowledge of market price and cost and pricing structures would enable a firm to assess monthly the minimum levels of throughput needed for breakeven and enable forward planning.

Furthermore, the model could be used to forecast monthly revenue and cash flow. Estimates of future monthly receipts could be obtained for a variety of different quantities or supply species mix enabling the firm to form a clearer picture of the flow of funds in and out of the business.

Having reviewed a range of applications of the model as a device for explanation and forecasting, the final section discusses the major directions in which it is suggested further research should progress.

9.5 Recommendations for Further Research

While this research project has made a positive contribution to the fish marketing and distribution literature, developing the rather sketchy understanding of such systems into a deeper understanding with an analytical model with a range of useful applications, it would be wrong to regard this achievement as the ultimate end. Rather the model developed here should provide a spring board for much more research and study into the problems facing fresh fish distribution systems. In fact, the nature of this thesis, effectively venturing into unchartered territory, suggests many areas and directions of future research. While this is the case, this section seeks to suggest some of those considered most important and likely to bear fruitful results, and as such is selective rather than comprehensive.

A natural first area of development, is to actually apply the model as it has been developed to a relevant and contemporary problem facing the port merchant sector based in the South West. Whilst there are potentially many, a suitable problem would appear to be the problem of quotas on important demersal species such as Dover Sole and Monkfish. The application of the model to a problem such as this would highlight the effectiveness of the model as a planning tool and also raise any problems in its use as a forecasting tool, which could then be addressed.

Leading on from this, one comes to a central problem of forecasting in general which could also become a focus of attention. The relationships in the model provide a basis for forecasting into the future (subject to the standard assumption that they do not change in the meantime). However, one is still left with something of a problem in that independent variables need to be forecast. It is all very well developing the breakeven analysis, say into 1988 and concluding that the sector needs a supply of 120,000 stone of demersal fish in August in order to make any profit. While this is very useful information, it does not answer the question; what will actually be the level of demersal supply in that month in that year? For particular demersal species where quotas are being set either annually or bi-monthly, the problem is not so serious as an estimate of monthly supply of that species can be derived. However, many species are not on quota, leaving one with the problem of forecasting the independent variable. The way forward in an attempt to resolve this problem is not wholly clear, although two possible areas suggest themselves. Firstly, one could subject supply data to a modelling process in an attempt to provide a basis for estimating likely levels into the future. One area worthy of possible investigation might be the technique of Time Series Analysis which attempts to use patterns in the existing data as a basis for forecasting. One problem with this though, is that fish stocks are subject to exogenous variability, as is the fisherman's ability to catch them. Another possible area might be to attempt to develop models of supply which incorporate economic and biological features in an attempt to provide estimates of future levels of supply. It is accepted that this is a problematic area, although should be investigated.

The model developed in this thesis has discussed influences upon demersal profitability as a whole, and the majority of applications have been discussed in demersal terms. While this presents an important, global view of the sector, it should not detract from research effort into the profitability of individual species. More detailed impacts of phenomena such as quotas would be able to be studied if cost and pricing models could be developed for individual species. While it is recognised that this may well be problematical given the manner in which port merchants collect and collate data, again efforts should be made. Perhaps, merchants could be encouraged to keep logs of purchase prices and selling prices for major species, enabling more accurate data to be obtained as the basis of individual models of profitability. The successful estimation of individual species models based on the principles of the global demersal model would provide a more detailed analysis of the situation in the port merchant sector.

The successful econometric models estimated should also be the subject of further investigation and attempted improvement. Further modelling should be directed in two ways. Firstly, the models should be developed to include more detailed influences. For example, in the demersal model, the seasonal co-efficients have a variety of meanings. Attempts should be made to separate out these influences and include them explicitly in the model. For example, some variable relating to the proportion of high unit value species might be included. Inclusion of relevant seasonal variables would ensure the already good explanatory and forecasting abilities of the model. Secondly, the individual species models should continue to be developed. Again the search for additional relevant variables should be included. Also, with the individual models effort should be made into determining the interrelationships that exist between important species, not just at the same ports in the South West, but elsewhere as well. It seems logical that supply and prices of one species will influence purchase prices of another. Attempts to investigate these should be encouraged.

In general, while the models have been successfully estimated, other econometric techniques need to be investigated as alternatives; the aim here is to continually attempt to improve the power of the models in order to arrive at more accurate forecasting models.

The same principle applies to the cost and pricing models. They have been successfully and accurately developed from representative sample data. However, attempts should be undertaken to increase the detail of the models as well as determining whether other forms of the models (e.g. non-linear cost model or absolute percentage spread pricing model) might be more appropriate. In particular here, is to attempt to determine whether the cost and pricing models vary seasonally in any other way other than that suggested in the estimated model.

The final area of suggestions here is one of the most important. The model has been estimated for the major level of the system in the South West, the port merchant sector. The principles and uses of the model should be developed for other levels of the system where they would be equally useful. For example, models of the major inland wholesale markets could be developed in the same way with a similar range of applications. These models could also be developed to reflect supply and demand relationships for a variety of sources of supply. In addition, at higher levels of the fresh fish distribution system, opportunities would arise to test a variety of specifications of demand models, other than the single equation model developed in this thesis. At higher levels, the assumption of supply inelasticity might be inappropriate, other forms such as simultaneous systems of equations may well be more suitable.

The aim of this section has been to emphasise that this thesis is a start point for further study in a variety of directions. It is a sincere hope that the development of this model will both increase our understanding of the problems facing a unique industry and provide an incentive for more research into this previously neglected sector of the fishing industry.

BIBLIOGRAPHY

ALDERSON W (1954) Factors Governing the Development of Marketing Channels. In CLEWETT R M (ed). Marketing Channels for Manufactured Products, Homewood, Illinois: R D Irwin Inc.

ALDERSON W (1957) Marketing Behaviour and Executive Action. Homewood, Illinois: R D Irwin Inc.

ALLAN C M (1973) The Demand for Herring: a Single Equation Model. In WAGNER L (ed). Readings in Applied Microeconomics. Oxford University Press.

ASPINALL L (1958) The Characteristics of Goods and Parallel Systems Theories. In KELLEY E J and LAZER W: Managerial Marketing : Perspectives and Viewpoints. Harewood, Illinois : R D Irwin, Inc.

BAUMOL W J (1973) On Empirical Determination of Demand Relationships. In WAGNER L. Readings in Applied Microeconomics. Oxford University Press.

BECKMANN T N and DAVIDSON W R (1967) Marketing. New York. Ronald Press.

BREYER R F (1934) The Marketing Institution. New York. McGraw-Hill.

BUCKLIN L P (1966) A Theory of Distribution Channel Structure. University of California, Institute of Business and Economic Research.

BUCKLIN L P (1967a) Postponent, Speculation and the Structure of Distribution Channels. In MALLEN B E The Marketing Channel - A Conceptual Viewpoint. New York: John Wiley and Sons.

BUCKLIN L P (1967b) The Economic Structure of Channels of Distribution. In MALLEN B E The Marketing Channel: A Conceptual Viewpoint. New York: John Wiley and Sons.

BUCKLIN L P (1970) Vertical Marketing Systems. Glenview, Ill.: Scott, Foresman.

BUCKLIN L P and HALPERT M (1965) Postponement Speculation and the Structure of Distribution Channels. Journal of Marketing. Vol. 2. No.1.

BUCKLIN L P and STASCH S F (1970) Problems in the Study of Vertical Marketing Systems. In BUCKLIN L P (ed): Vertical Marketing Systems. Glenview, Ill.: Scott, Foresman.

BUCKLIN L P and CARMAN J M (1976) Vertical Market Structure Theory and the Health Care Delivery System. In SHETH J N and WRIGHT P L. Marketing Analysis for Societal Problems. Urbana, Ill.: University of Illinois Bureau of Economic and Business Research.

CARTWRIGHT I (1982) An Examination of the Decline in Fresh Fish Sales with Special Reference to Traditional Fishmongers. Plymouth Polytechnic. BSc Fishery Science Final Year Project.

CHAN K W and LEE N K (1978) Marketing of Fresh Marine Fish in Hong Kong. Indo Pacific Fishery Commission Proceedings. 18th session. Manila.

CHENG K W J (1978) Post Harvest Handling and Marketing of Freshwater Fish in Hong Kong. Indo Pacific Fishery Commission Proceedings. 18th session. Manila.

COLMAN D (1972) The Demand for Fish in the U.K. : A Further Analysis. White Fish Authority.

COLMAN D and YOUNG T. (1970) Expenditure on Fish by Households in Great Britain. White Fish Authority. Fishery Economics Research Unit.

CRAMER J.S. (1971) Empirical Econometrics. North Holland. Amsterdam.

COMMISSION OF THE EUROPEAN COMMUNITIES (1982) Northern Britain. Internal Information on Fisheries.

COURTNEY P L (1971) The Wholesaler as a Link in the Distribution Channel. In MOLLER W G and WILEMON D L. Marketing Channels - A Systems Viewpoint. Homewood, Illinois : R D Irwin Inc.

CRAWFORD K W (1978) Marketing Tilipia an Chinese Carps Symposium on Culture of Exotic Fishes. Fish Culture Section. American Fisheries Society.

DAVIDSON W R (1970) Changes in Distributive Institutions. Journal of Marketing. Volume 34 No. 1.

DESAI M (1976) Applied Econometrics. Philip Allan.

DEVON SEA FISHERIES COMMITTEE 8th July 1983. Quarterly Report. Devon Sea Fisheries Committee.

EXPENDITURE COMMITTEE (1978) Fifth Report from the Expenditure Committee of the House of Commons. HMSO.

FOX K A (1958) Econometric Analysis for Public Policy. Iowa State College Press.

GATTORNA J (1978) Channels of Distribution Conceptualisations : A State-of-the-Art Review. European Journal of Marketing. Vol.12 No.7.

GUERRERO C V (1978) Processing and Marketing of Dried Fish in Cebu and Bohol, Philippines. Indo Pacific Fishery Commission Proceedings. 18th session. Manila.

HALL M (1971) The Theory of Wholesale Distribution. In MOLLER W E and WILEMON D L. Marketing Channels - A Systems Viewpoint. Homewood Illinois: R D Irwin Inc.

HALBERT M (1965) The Meaning and Sources of Marketing Theory. New York: McGraw-Hill.

HAY D A and MORRIS D J (1979) Industrial Economics: Theory and Evidence. Oxford University Press.

HOLLANDER S L (1960) The Wheel of Retailing. Journal of Marketing. Volume 24, Number 3.

HOLLANDER S L (1961) Measuring the Cost and Value of Marketing. MSU Business Topics. Bureau of Business and Economic Research, Graduate School of Business Administration. Michigan State University.

JOHNSTON J (1984) Econometric Methods. McGraw-Hill.

KENNEDY P (1979) A Guide to Econometrics. Oxford : Martin Robertson.

KEYNOTE (1982) Fish Retailing. Keynote Business Information.

KLEIN L R (1962) An Introduction to Econometrics. Prentice Hall Inc.

KOTLER P K (1980) Marketing Management. London. Prentice-Hall Int. Inc.

LAZARUS C Y (1971) The Retailer as a Link in the Distribution Channel. In MOLLER W E and WILEMON D L. Marketing Channels - A Systems Viewpoint. Homewood, Illinois: R D Irwin Inc.

MADDALA G S (1977) Econometrics. McGraw-Hill.

MALLEN B E (1967) The Marketing Channel - A Conceptual Viewpoint. New York: John Wiley and Sons.

MALLEN B E (1972) Just How Much Does Marketing and Distribution Cost in the Canadian Economy. Business Quarterly Autumn 1972.

MALLEN B E (1973) Functional Spinn Off : A Key to Anticipating Change in Distribution Structure. Journal of Marketing. Vol. 37.

MALLEN B E (1977) Principles of Marketing Channel Management D C Heath and Company.

McCAMMON B C (1964) Alternative Explanations of Institutional Change and Channel Evolution. In MALLEN B E: The Marketing Channel - A Conceptual Viewpoint. New York: John Wiley and Sons.

McCAMMON B C and LITTLE R W (1965) Marketing Channels : Analytical Systems and Approaches. In SCHWARTZ G (Ed). Science in Marketing. New York. John Wiley and Sons Inc.

McCOY E W and HOPKINS M L (1980) Processing and Marketing. In Fish Farming Handbook. Eds BROWN E E and GRATZEK J B.

McINNES W (1964) A Conceptual Approach to Marketing. In COX R, ALDERSON W, SHAPIRO S. Theory in Marketing. American Marketing Association.

MacSWEEN I M (1973a) Attitudes to Fish. Fishery Economics Research Unit Reference Paper. White Fish Authority.

MacSWEEN I M (1973b) Frequency of Serving Fish. Fishery Economics Research Unit Reference Paper. White Fish Authority.

MacSWEEN I M (1973c) Fish and Other Foods - A Comparison of Attitudes Fishery Economics Research Unit Reference Paper. White Fish Authority.

MINISTRY OF AGRICULTURE, FISHERIES AND FOOD (1938-1982) Sea Fisheries Statistical Tables. HMSO Annual.

MINISTRY OF AGRICULTURE, FISHERIES AND FOOD (1981a) The Marketing of Fish. Report presented by WIGHT R, CROSS J, STEVENSON D. London.

MINISTRY OF AGRICULTURE, FISHERIES AND FOOD (1981b) Marketing and Processing of Agricultural Products: Programme for the Fisheries Sector in England and Wales. London. HMSO.

MINTEL (1981) Fresh Fish. A MINTEL Market Intelligence Report.

MOORE A and PALFREMAN D A (1971) The Schools Market for Fish. Fishery Research Unit Reference Paper. White Fish Authority.

MOORE A (1971) *The Market for Fish in Britain : An Economic Analysis for Use in Policy Formulation*. Fishery Economics Research Unit Reference Paper. White Fish Authority.

MOYER M S and WHITMORE N M (1976) An Appraisal of the Marketing Channels for Automobiles. *Journal of Marketing*. Volume 40, Number 3.

NATIONAL FOOD SURVEY COMMITTEE (1980) *Household Food Consumption and Expenditure*. Annual Report of the National Food Survey Committee. HMSO.

NICHOLLS J P (1979) *Seafood Marketing Problems : Marketing Orders and Other Alternatives for Fishermen*. U.S. National Maritime Fisheries Service. Washington D.C.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (1982) *Review of Fisheries in OECD. Member Countries*. OECD Paris.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (1984) *Review of Fisheries in O.E.C.D. Member Countries*. OECD Paris.

O'ROURKE A D and De LOACH D B (1970) *The Californian Fresh and Frozen Fishery Trade*. Californian Agricultural Experiment Station. Bulletin 850. University of California.

PEARSON J M (1983) *A Note on the Use of Seasonal Dummy Variables*. Dept of Economics and Public Administration. Trent Polytechnic.

PENN E S and CREWS W J (1979) *Value Added, Margins and Consumer Expenditure for Edible Fishery Products in the United States, 1976-78*. National Marine Fisheries Service. Washington D.C.

PENN E S (1980a) *Marketing Bill and its Cost Components of U.S. Food Fish Products*. National Marine Fisheries Service. Washington D.C.

PENN E S (1980b) *Cost Analysis of Fish Price Margins, 1972-77, at Different Production and Distribution Levels*. National Marine Fisheries Service, Washington, D.C.

PERKINS R J (1969) — A Study of Inland Fish Wholesale Markets. Fishery Economics Research Unit. White Fish Authority.

PILI F and ABELLA F (1978) — Methods for Processing and Distribution of Fish and Fishery Products in the Philippines. Indo Pacific Fishery Commission Proceedings, 18th Session, Manila.

PINDYCK R S and RUBINFELD D L (1981) — Econometric Models and Economic Forecasts. McGraw-Hill.

PRICE COMMISSION (1976) — Prices and Margins in the Distribution of Fish. Price Commission Report Number 14. HMSO.

PROCHASKA F J (1978) — Prices, Marketing Margins and Structural Change in the King Mackerel Marketing System. Southern Journal of Agricultural Economics. Volume 10, Part 1.

ROBINS M (1982a) — A Study of Birmingham Inland Wholesale Market. Sea Fish Industry Authority.

ROBINS M (1982b) — The Transportation of Fresh Fish in the South West. Sea Fish Industry Authority.

RITSON C, LESSER D and GOFTON L R (1982) — Marketing British Caught Fish. Department of Agricultural Marketing. Report No. 28. University of Newcastle upon Tyne.

ROSSON P J (1974) — Changing Traditional Distribution Systems: Fish Marketing in Tanzania, International Journal of Physical Distribution. Volume 4. Number 5.

ROSSON P J (1975) — Fish Marketing in Britain. European Journal of Marketing. Volume 9, No. 3.

SCHAREY P B et al (1972) — Analysis and Simulation of a Distribution Channel: A Case Study in Seafood Marketing. International Journal of Physical Distribution. June 1972.

SEA FISH INDUSTRY AUTHORITY (1980) — Fish Retailer Purchase Study Report. Fishery Economics Research Unit. White Fish Authority.

SEA FISH INDUSTRY AUTHORITY (1980-1983) Household Fish Consumption in Great Britain. Quarterly. Fishery Economics Research Unit.

SEA FISH INDUSTRY AUTHORITY (1981) Business Study of the Fish Industry at Grimsby. Industrial Development Unit, Report Number MD 470.

SEA FISH INDUSTRY AUTHORITY (1983a) Interim Report on the Distribution System for Fresh Fish. Industrial Development Unit. Occasional Paper.

SEA FISH INDUSTRY AUTHORITY (1983b) British Survey of Eating Out Fish. Fishery Economics Research Unit. Occasional Paper Number 3.

SEA FISH INDUSTRY AUTHORITY (1984) Trade Bulletin. United Kingdom Imports and Exports of Fish and Fish Products. Monthly.

SLAYMAKER J E (1983) Approaches to the Study of Marketing and Distribution Channels. Gestion Cientifica. Vol.I, No.3. Universidad Nacional de Educacion a Distancia, Madrid.

STERN L W (1969) Distribution Channels Behavioural Dimensions. Houghton Mifflin Company, Boston.

STERN L W and GILL L E (1966) Roles and Role Theory in Distribution Channel Systems. In STERN L W : Distribution Channels : Behavioural Dimensions. Houghton Mifflin Company. Boston.

STERN L W and EL-ANSARY A (1977) Marketing Channels. Prentice Hall Inc.

STERN L W and STURDIVANT F D (1976) Discussion of Vertical Market Structure Theory and the Health Care Delivery System. BUCKLIN L P and CARMAN J M. In Marketing Analysis for Societal Problems. Urbana, Ill.: University of Illinois Bureau of Economic and Business Research.

STEWART P W and DEWHURST J F (1939) Does Distribution Cost Too Much? New York. Twentieth Century Fund.

STIGLER G J (1951) The Division of Labor is Limited by the Extent of the Market. Journal of Political Economy. Volume 54.

STURDIVANT F D (1970) Distribution in American Society: Some Questions of Efficiency and Relevance. In BUCKLIN LP. Vertical Marketing Systems. Glenview, Ill.: Scott, Foresman.

TAYLOR R A (1960) The Economics of White Fish Distribution in Great Britain. London. Duckworth.

THOMAS J J and WALLIS K F (1970) Seasonal Variation in Regression Analysis. Journal of the Royal Statistical Society. Vol.134.

THOMAS R L (1985) Introductory Econometrics: Theory and Applications. Longman. London.

VAILE R S, GRETHER E T and COX R (1952) Marketing in the American Economy. New York. Ronald Press.

WHITE FISH AUTHORITY (1974) An Analysis of the Movements in Fish Prices. White Fish Authority. Fishery Economics Research Unit.

WHITE FISH AUTHORITY (1977) Price/Supply Relationships for Demersal Fish in the U.K. Fishery Economics Research Unit.

WONNACOTT R J and WONNACOTT T H (1970) Econometrics. J. Wiley & Sons.

YAP C L (1978) The Middleman in Fish Marketing: An Appraisal. Journal of Agricultural Economics and Development. July 1978.

YOUNG T (1976) A Study of the Demand for Fish in the United Kingdom. Department of Agricultural Economics. University of Manchester.

INTERVIEW QUESTIONNAIRE

Introduction

I am a research student at Plymouth Polytechnic where I am working on a project concerned with the marketing and distribution system operating for fresh fish in the South West of England.

Part of my research entails a consideration of the port wholesaling function which is why I am here to ask you some questions about your operation, if that is alright with you!

May I just state that any information that you give me will, of course, be treated in total confidence.

Questions

1. Where do you get your supplies from?
e.g. Plymouth, Brixham, other wholesalers, etc.

2. What proportion of your purchases come from these sources?
[Or how important is Plymouth/Brixham to you (e.g. 75%)].

3. Is there much variation in the proportions?

4. How much of your purchases are made up of fresh fish?

5. Do you buy frozen or smoked fish? If so, what proportion of purchases.

6. What proportion of your purchases are :
(a) fish
(b) shellfish
(c) other?

If fish a greater % than shellfish then :

7. What are the most important species of fish (Top 5).

8. Of your purchases of shellfish, which are the most important species?

9. What was the value of your purchases last year?

10. Do you undertake any further processing or freezing?
If yes?

11. Can you give any idea what 'proportion' of sales are processed products? (Other than fresh fish).

12. What proportion of total sales are outwith South West England?

13. Of sales within the region (Devon and Cornwall), do you mainly supply:

    (a) customers
    (b) retailers
    (c) hotels and restaurants
    (d) other wholesalers
    (e) processors

14. Of your sales which leave the South West, what proportion is exported?

15. Of sales which go elsewhere in the U.K., what proportion goes to :

    (a) Billingsgate
    (b) Birmingham
    (c) Other inland wholesale markets
    (d) Direct to other customers

16. With relation to the last question, do you transport your own fish or, if not, who does?

17. In what form is your fish transported?

18. What was the value of your sales last year?

On completion of this section of the interview, port merchants were then asked if they would be willing to provide a more detailed cost breakdown of their business activities for 1982. If merchants agreed, then the interview proceeded to ascertain the cost structures of the business.

DATA SERIES

Demersal

Dover Sole

Hake

Lemon Sole

Monkfish

Plaice

DEMERSAL

Monthly data series of price (£) and quantity (stones) from January 1978 to December 1982 at January 1978 prices.

	Price	Quantity
1	3.99465	51532
2	4.18443	46498
3	4.49468	55537
4	4.84492	75338
5	4.19174	81712
6	3.95565	102795
7	4.21159	76318
8	4.29055	94138
9	4.41140	100858
10	5.20552	78463
11	5.15283	68715
12	6.13432	29272
13	5.37862	49954
14	5.21947	43283
15	4.73773	71398
16	4.39327	102493
17	4.80950	59425
18	4.13139	121275
19	3.88296	125606
20	4.87617	101712
21	4.57735	86557
22	5.48792	101456
23	5.30562	68871
24	6.86109	46253
25	5.38608	107932
26	4.50100	91201
27	4.96328	87411
28	4.40640	113535
29	3.95887	104201
30	4.14900	104096
31	4.33929	130867
32	4.74639	109827
33	5.11234	107823
34	5.37853	80625
35	4.97508	92208
36	5.12766	86598
37	3.97747	165861
38	4.00807	107280
39	4.50932	78971
40	4.16588	117976
41	4.38754	115937
42	4.25773	125767
43	4.04321	166978
44	4.87384	173370
45	4.98899	146686
46	6.32097	118364
47	5.06843	142163
48	5.20037	104801
49	4.53031	108701
50	4.03970	176039
51	4.94841	144271
52	3.60393	178904
53	4.19379	141244
54	4.04636	227215
55	4.30249	209963
56	4.53488	17941
57	4.82642	136765
58	5.57658	137390
59	5.51762	100193
60	4.94508	169091

DOVER SOLE

Monthly data series of price (£) and quantity (stones) from January 1978 to December 1982 at January 1978 prices.

	Price	Quantity		Price	Quantity
1	13.5512	3438.6	38	14.5992	8824.0
2	14.9555	3268.1	39	16.4349	6563.6
3	15.0545	5637.1	40	12.8334	11957.5
4	15.7889	7849.4	41	14.9748	9572.0
5	14.6074	5595.3	42	17.2309	8937.9
6	15.6063	5260.1	43	18.2407	11992.3
7	16.9183	4931.2	44	17.8771	11098.1
8	16.1455	6227.3	45	19.5336	11493.7
9	17.4794	5900.9	46	19.5119	12472.8
10	16.4719	8788.2	47	16.8348	13287.2
11	19.1657	6571.6	48	18.8491	9807.2
12	17.9749	4728.3	49	15.0232	11498.9
13	15.3809	6835.8	50	14.5180	11936.4
14	15.6843	4709.0	51	14.5193	14076.4
15	14.1144	8459.1	52	12.1787	10221.4
16	13.9310	9882.3	53	13.2202	10322.6
17	14.0401	5489.4	54	13.9076	14209.3
18	15.4501	8712.9	55	15.2976	17906.9
19	17.2647	7353.1	56	14.5983	14612.7
20	16.2910	10865.1	57	14.2596	13360.4
21	17.8443	5677.0	58	13.5489	15123.1
22	17.1387	12528.7	59	13.6755	13858.3
23	16.4805	8551.4	60	15.1319	14238.1
24	18.0284	9006.4			
25	15.1546	14159.1			
26	14.8123	10294.6			
27	14.4916	11982.6			
28	12.8339	13278.9			
29	13.0720	7199.4			
30	15.2447	6748.0			
31	17.2660	8328.9			
32	17.7713	8752.6			
33	17.8868	8514.4			
34	15.9707	9515.4			
35	15.9801	9283.1			
36	16.5700	10140.7			
37	15.8068	11559.5			

HAKE

Monthly data series of price (£) and quantity (stones) from January 1978 to December 1982 at January 1978 prices.

	Price	Quantity		Price	Quantity
1	5.98299	951.2	40	4.80171	4406.3
2	5.18701	658.3	41	4.77029	5478.7
3	4.27277	603.1	42	4.56308	5530.7
4	6.32149	844.0	43	4.30422	7481.8
5	4.93925	1666.1	44	4.26445	5253.6
6	5.80258	1711.8	45	5.38892	4114.9
7	5.48804	1381.1	46	7.23136	4433.1
8	5.43699	1867.7	47	6.09389	4281.8
9	6.03483	1762.2	48	6.08517	3940.1
10	5.43982	1467.7	49	4.93872	2982.7
11	6.42665	831.5	50	6.40169	8188.9
12	6.75162	837.8	51	8.10494	6696.0
13	6.68726	1050.4	52	6.47881	6927.5
14	7.02411	489.7	53	5.10456	4411.0
15	7.73310	486.6	54	6.81101	16683.4
16	7.62268	633.1	55	5.05523	6376.4
17	7.79387	634.7	56	7.03863	9530.7
18	5.78491	1847.2	57	6.55380	3431.5
19	5.92500	1450.3	58	9.17354	8566.9
20	6.32416	1283.5	59	6.85998	2340.1
21	7.05191	1897.6	60	6.84437	11445.6
22	4.88023	1625.2			
23	4.90679	978.0			
24	5.43421	530.8			
25	4.57810	4042.6			
26	3.60970	3226.7			
27	4.79189	2370.1			
28	4.47835	2940.2			
29	5.21681	2606.3			
30	5.29025	2719.7			
31	5.29890	4055.1			
32	5.29790	4415.7			
33	5.46692	4124.4			
34	6.09278	2885.0			
35	4.31519	2519.7			
36	4.76860	1811.0			
37	5.10511	4988.9			
38	5.31951	2540.2			
39	5.82269	1990.6			

LEMON SOLE

Monthly data series of price (£) and quantity (stones) from January 1978 to December 1982 at January 1978 prices.

	Price	Quantity
1	6.93230	5124.7
2	6.37110	5610.8
3	6.56756	4446.2
4	5.96009	5993.7
5	5.06735	4867.8
6	6.17090	3608.1
7	6.11616	2730.4
8	6.54684	3048.0
9	6.46483	2049.0
10	6.64048	1798.7
11	7.05022	1112.9
12	7.13258	642.1
13	6.54600	3535.5
14	5.75637	4933.8
15	5.91311	7645.8
16	5.55677	9417.3
17	5.54737	4724.1
18	5.35590	6063.0
19	5.48078	4619.5
20	6.46332	5339.3
21	5.94692	3490.5
22	6.65333	3172.0
23	7.36815	1558.1
24	8.63091	2258.6
25	6.39023	12334.5
26	5.99426	11170.6
27	6.02523	9452.8
28	5.31831	12672.3
29	5.36084	6902.4
30	6.03504	3969.0
31	5.00358	6814.5
32	6.02522	4940.3
33	5.72844	5230.1
34	6.89974	2785.7
35	6.97165	2746.7
36	8.59559	3817.4
37	7.06844	9893.3
38	7.09426	9656.4
39	7.83986	7804.6
40	6.00364	8682.6
41	5.44322	5877.1
42	5.33344	6359.1
43	5.60045	6308.5
44	5.72309	6699.6
45	6.79985	5283.2
46	8.20733	3720.5
47	8.44337	3928.0
48	8.97914	2899.1
49	7.17197	5389.4
50	7.74404	8641.5
51	6.35787	12463.7
52	4.38902	11702.1
53	4.80087	9749.6
54	4.34779	9762.9
55	4.57386	9995.6
56	5.80762	6426.5
57	6.13425	5718.2
58	8.01838	3818.5
59	7.65605	3318.7
60	7.35211	4833.1

MONKFISH

Monthly data series of price (£) and quantity (stones) from January 1978 to December 1982 at January 1978 prices.

	Price	Quantity		Price	Quantity
1	8.0038	1628.1	40	8.6053	8589.1
2	7.9406	1938.5	41	8.9575	11893.3
3	7.5068	2000.1	42	8.7728	11656.9
4	8.1065	4492.8	43	8.3140	13859.2
5	7.5270	4822.1	44	8.9101	13490.3
6	7.2712	4430.2	45	8.6068	14167.7
7	7.9398	3196.1	46	10.6012	12253.2
8	8.0986	5217.3	47	9.7274	13455.0
9	8.5115	5930.4	48	9.6870	8777.4
10	8.0492	7115.3	49	8.9707	7479.4
11	7.9020	5027.8	50	7.6868	10644.3
12	8.5555	1516.0	51	9.2386	13298.2
13	7.3191	3021.6	52	7.4093	17282.2
14	7.4061	3198.1	53	9.2074	14307.1
15	8.4364	3521.7	54	6.6293	27431.6
16	8.3147	5466.2	55	8.2643	18794.1
17	7.5524	5555.0	56	6.8719	22143.1
18	7.0453	8452.2	57	7.8235	17053.7
19	6.3888	7162.7	58	8.5150	17017.9
20	6.8207	8457.2	59	9.6997	10867.9
21	7.4193	7849.7	60	7.0246	25289.7
22	7.2667	10326.7			
23	7.5017	7127.1			
24	7.0117	3922.6			
25	7.4242	9309.7			
26	5.7598	7283.8			
27	6.5536	7185.8			
28	6.0675	12633.3			
29	6.9594	10368.4			
30	7.2655	11128.9			
31	7.6571	13309.9			
32	8.5751	10235.2			
33	8.8280	11779.5			
34	6.9844	13009.6			
35	6.8990	12472.0			
36	7.7274	8497.9			
37	7.8770	12303.2			
38	6.9676	9520.6			
39	7.8687	6707.6			

PLAICE

Monthly data series of price (£) and quantity (stones) from January 1978 to December 1982 at January 1978 prices.

	Price	Quantity		Price	Quantity
1	3.89160	2858.7	41	2.60185	11761.1
2	2.54780	4538.4	42	2.90656	13006.6
3	2.92629	4953.3	43	2.85487	16537.4
4	2.71396	7529.1	44	3.18406	13377.9
5	3.10975	6946.5	45	3.70476	12273.9
6	3.86311	6942.6	46	3.89644	11869.8
7	4.41914	5283.0	47	4.46415	9810.8
8	4.32191	6200.6	48	4.29915	5647.1
9	4.42184	5683.7	49	2.92761	6344.8
10	3.52455	6928.7	50	2.07308	15774.7
11	4.89162	4280.7	51	1.99303	13899.2
12	4.32199	1834.2	52	2.11016	14115.9
13	4.07793	2803.2	53	2.71854	13403.0
14	2.98951	3455.1	54	2.52758	17408.1
15	2.64520	6523.3	55	2.78690	19189.4
16	2.65338	8809.7	56	3.56428	13396.7
17	3.52151	6069.4	57	3.50302	12795.4
18	3.36815	8513.3	58	3.12541	14400.2
19	4.18197	6496.7	59	3.60928	9374.2
20	4.07237	9062.1	60	3.94054	7427.2
21	4.30129	4511.1			
22	4.07198	8844.6			
23	4.52427	4847.5			
24	4.89654	4453.2			
25	3.90043	4783.9			
26	2.12196	9010.7			
27	2.63903	8126.0			
28	2.80980	7427.9			
29	3.38401	5615.8			
30	3.35803	7230.5			
31	3.74563	8977.6			
32	3.32013	9610.5			
33	3.35731	9025.1			
34	3.48277	7463.1			
35	3.65860	5826.8			
36	3.78082	5336.0			
37	2.81267	10187.4			
38	1.73588	12324.3			
39	1.79380	10965.5			
40	1.80027	12508.7			

SEASONALITY IN PRICE AND QUANTITY

Lemon Sole

Plaice

Dover Sole

Monkfish

Demersal

Figure 1

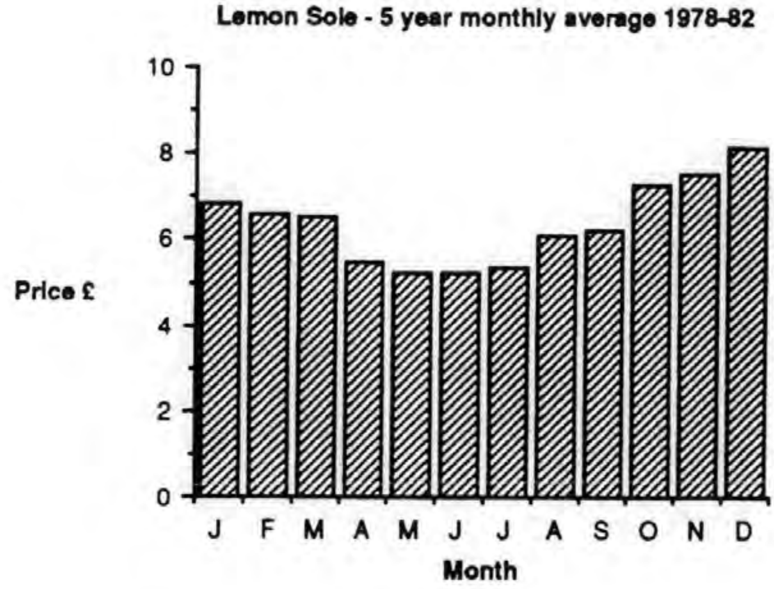


Figure 2

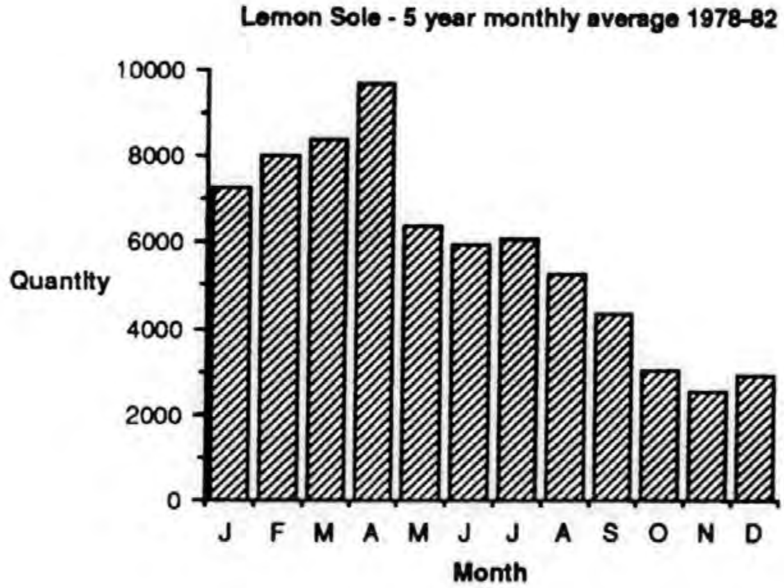


Figure 3

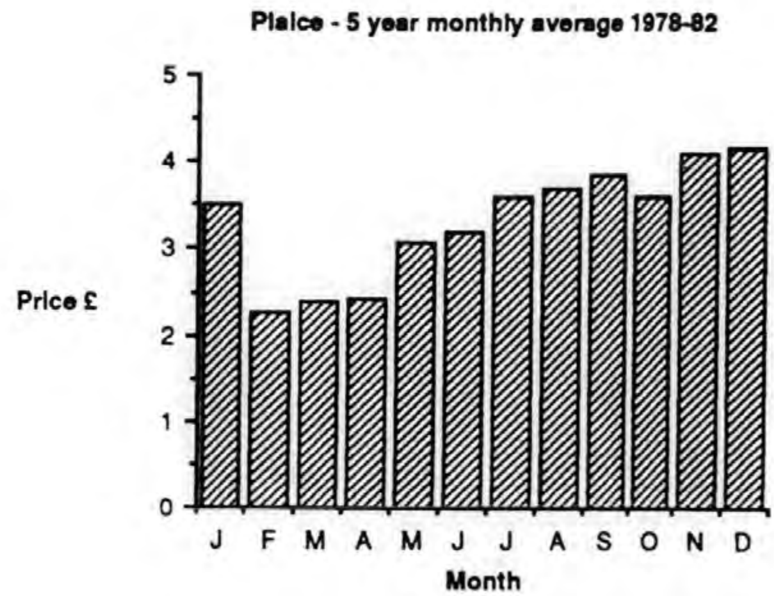


Figure 4

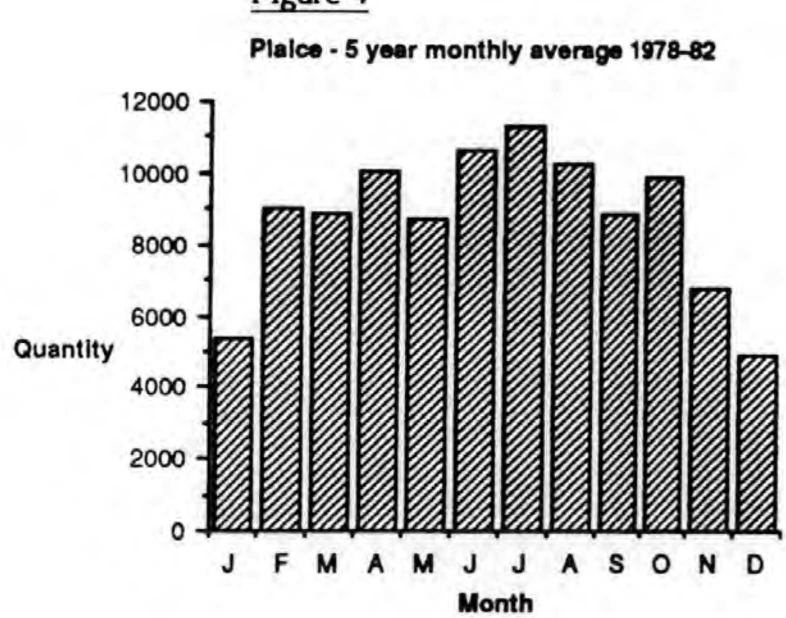


Figure 5

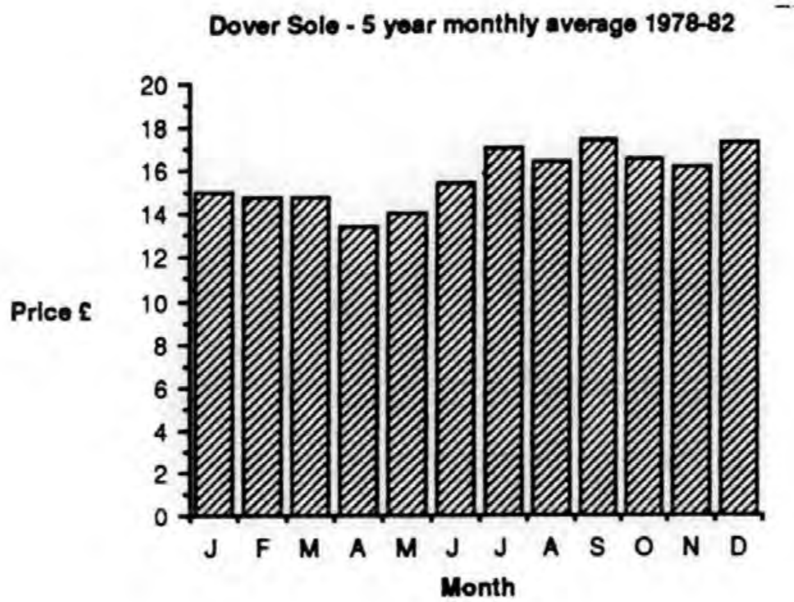


Figure 6

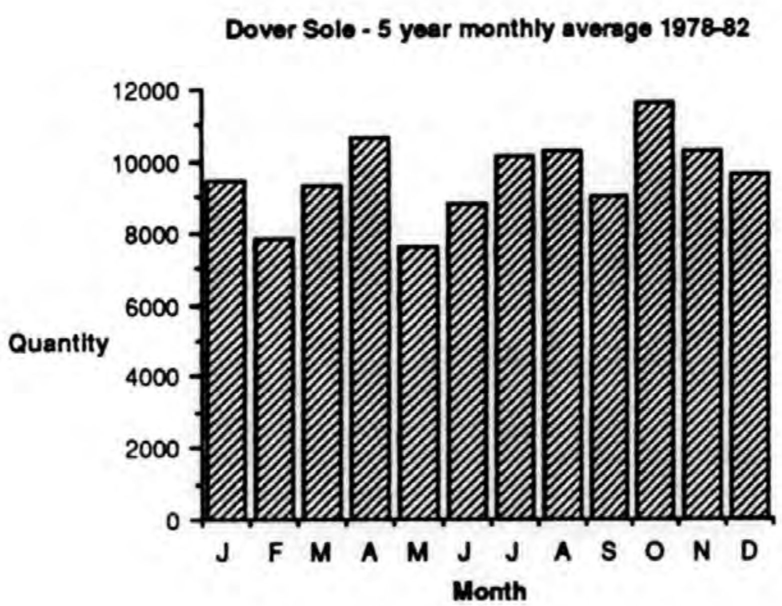


Figure 7

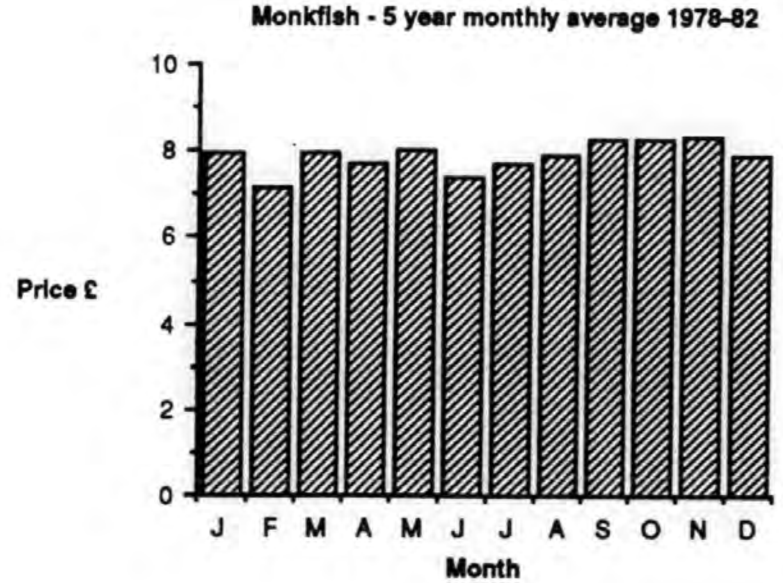


Figure 8

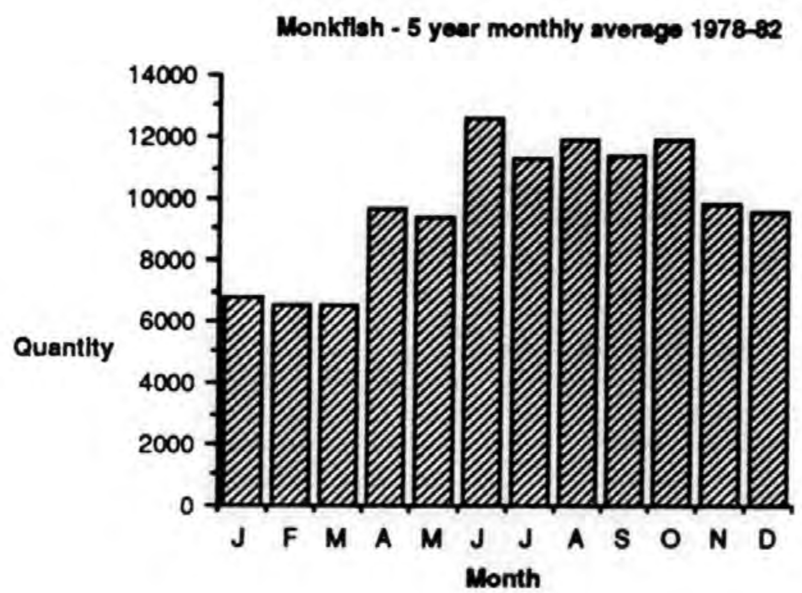


Figure 9

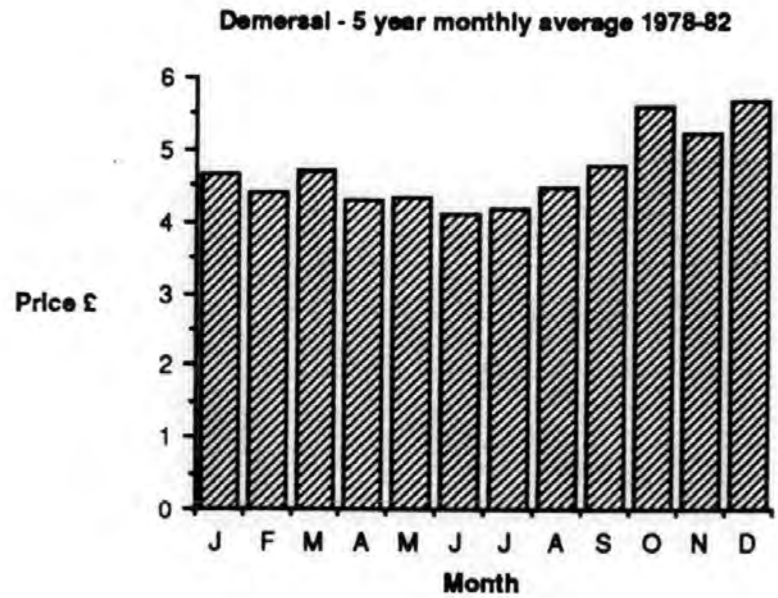
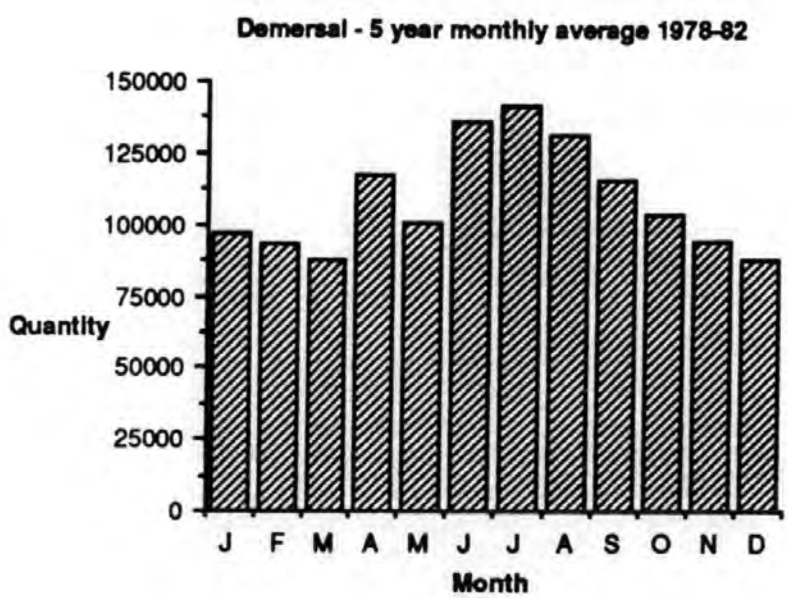


Figure 10



MODEL FORECASTS

Dover Sole

Monkfish

Lemon Sole

Plaice

Demersal

Figure 1

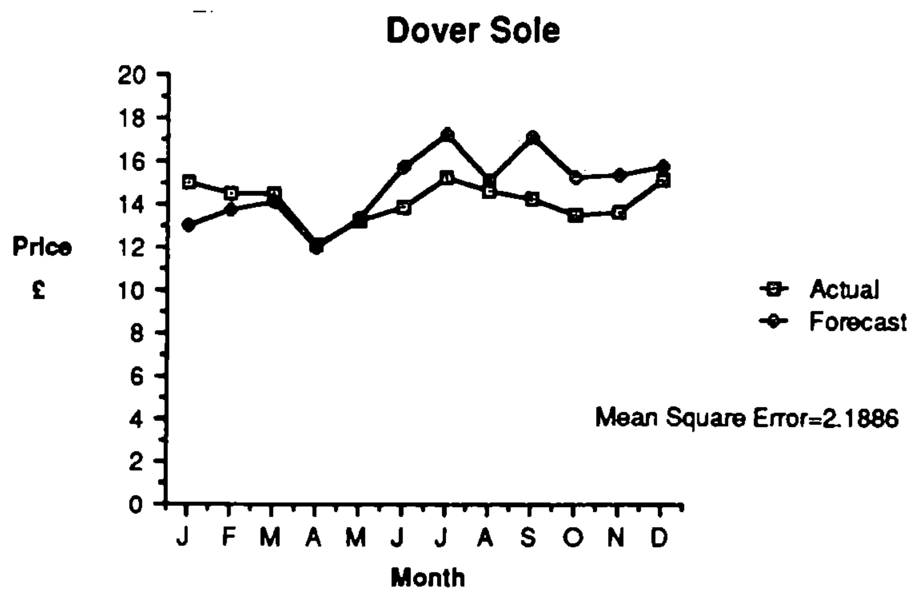


Figure 2

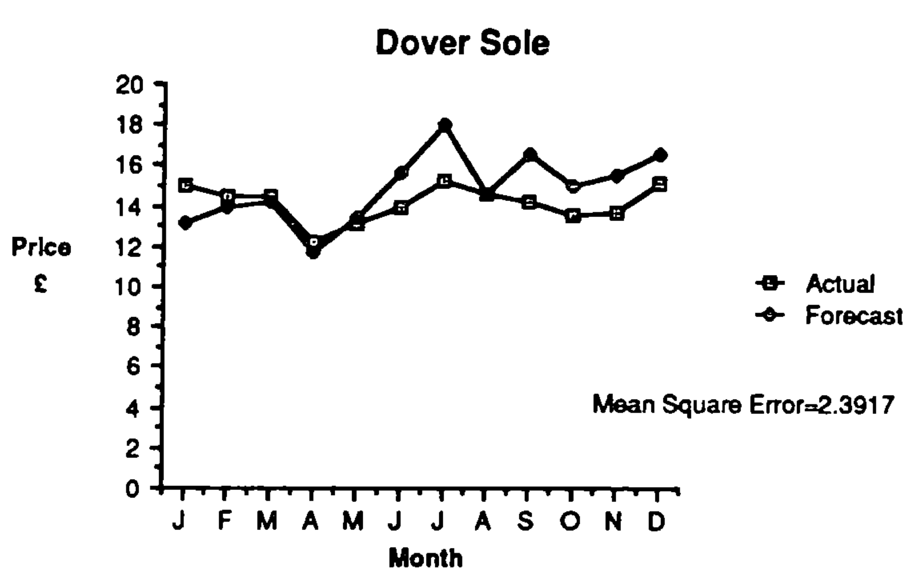


Figure 3

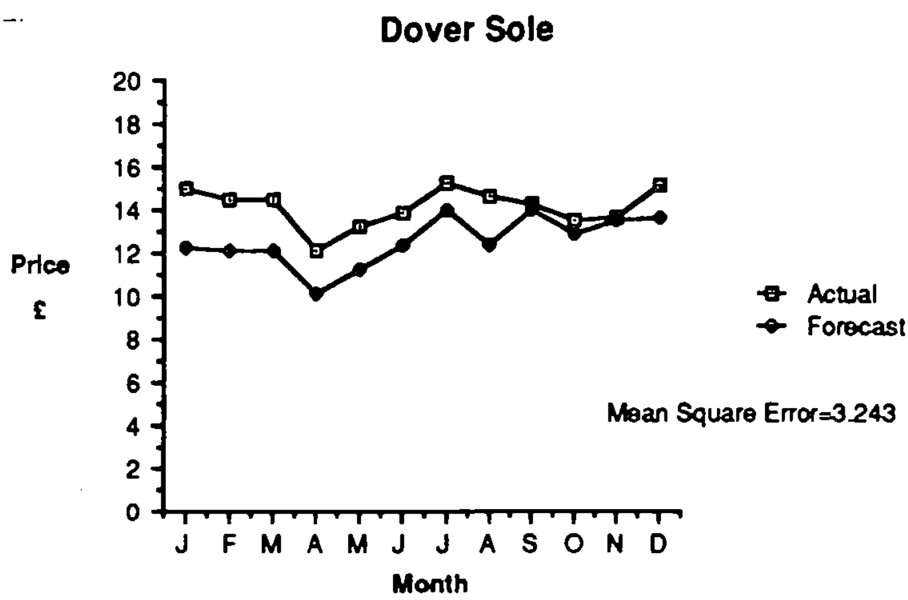


Figure 4

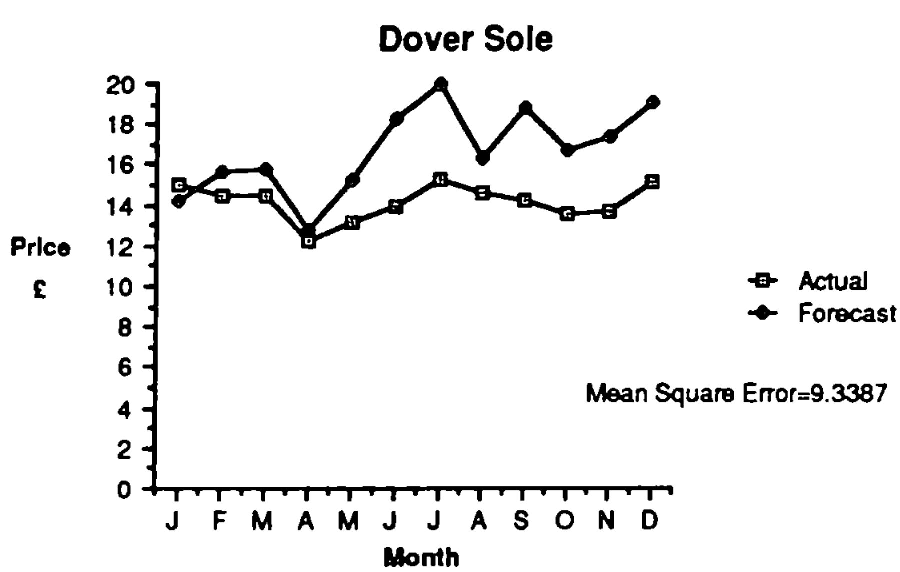


Figure 5

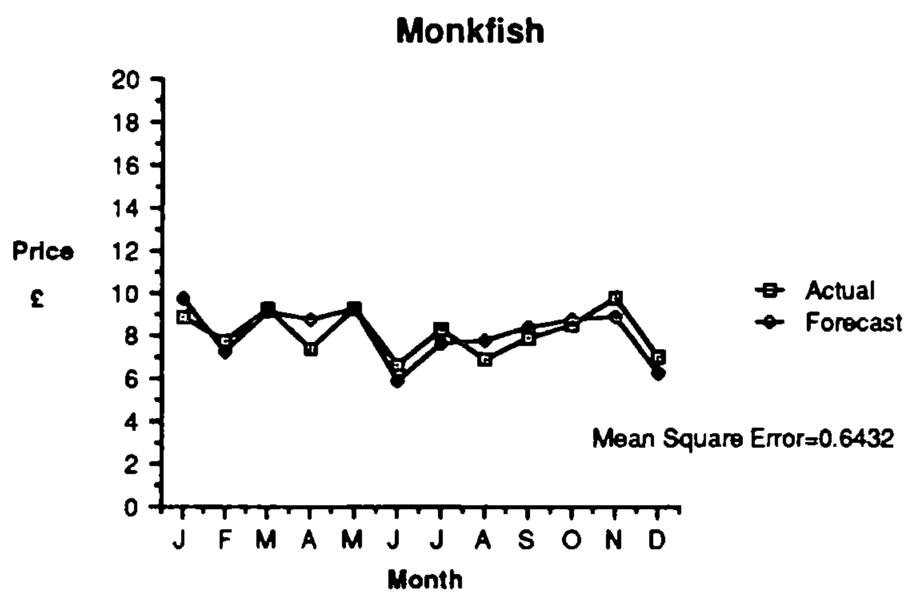


Figure 6

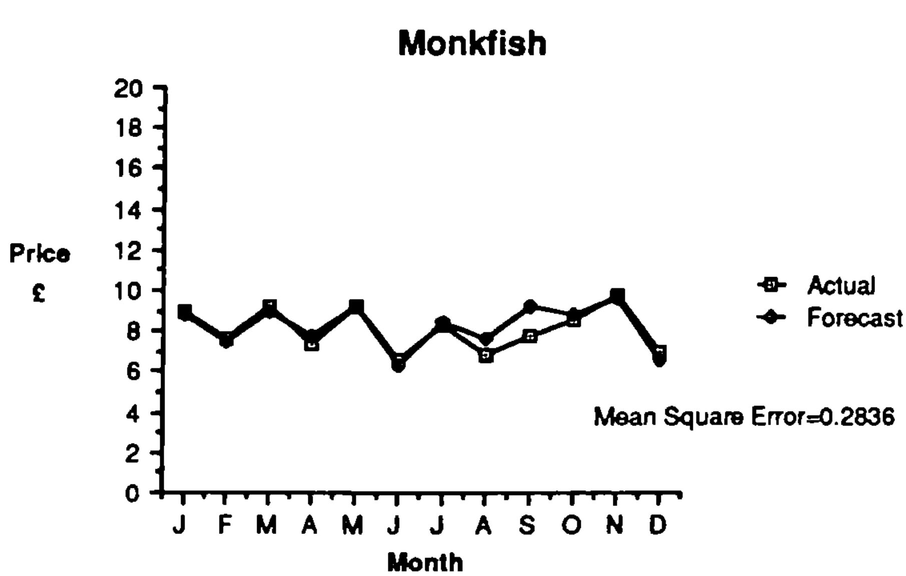


Figure 7

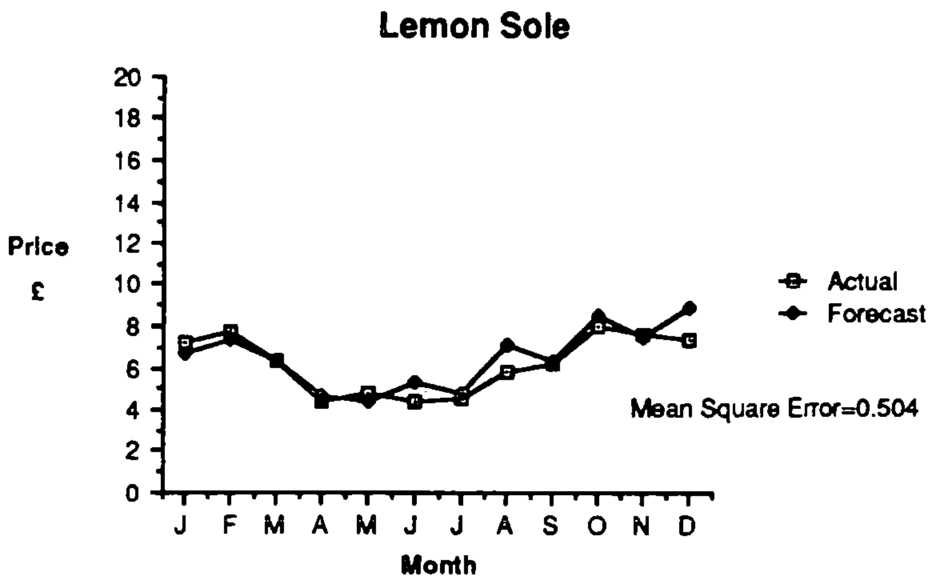


Figure 8

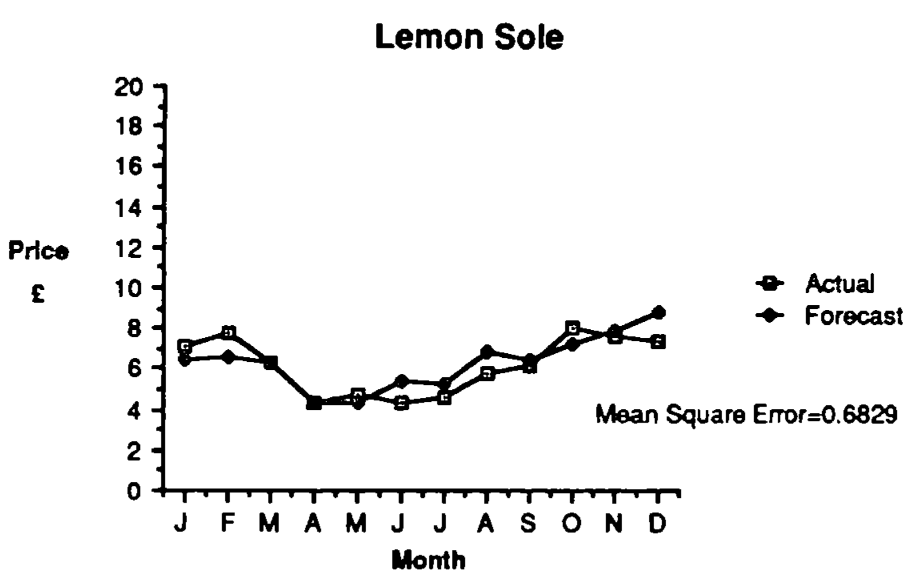


Figure 9

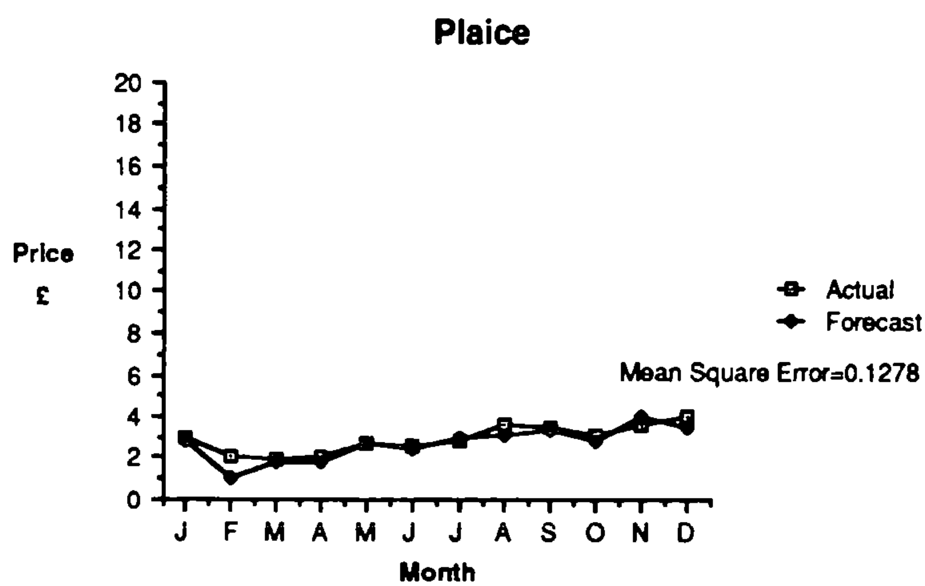


Figure 10

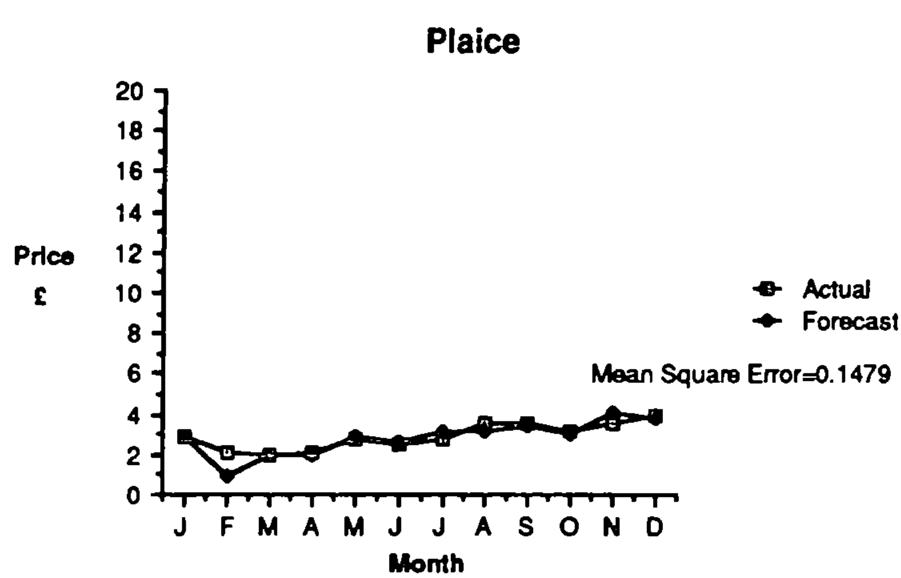


Figure 11

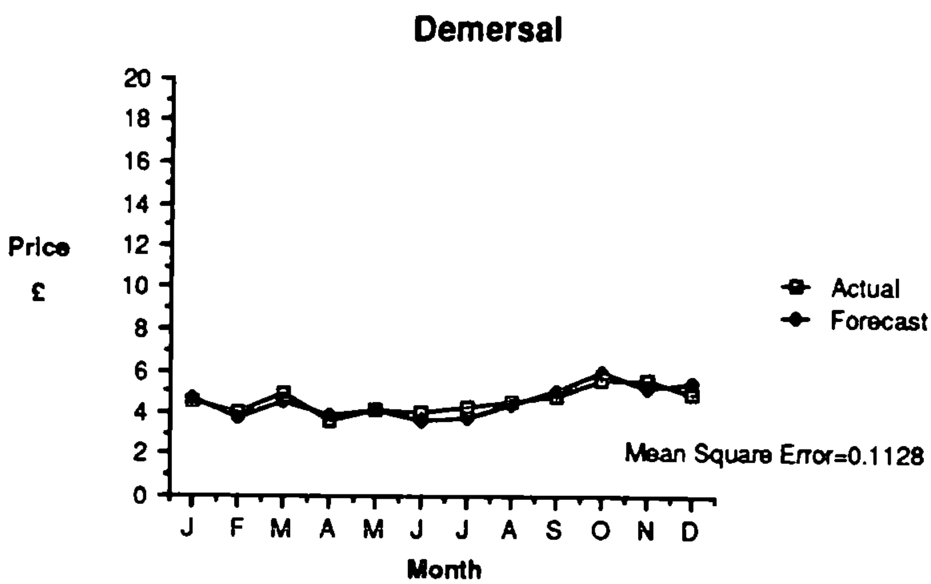
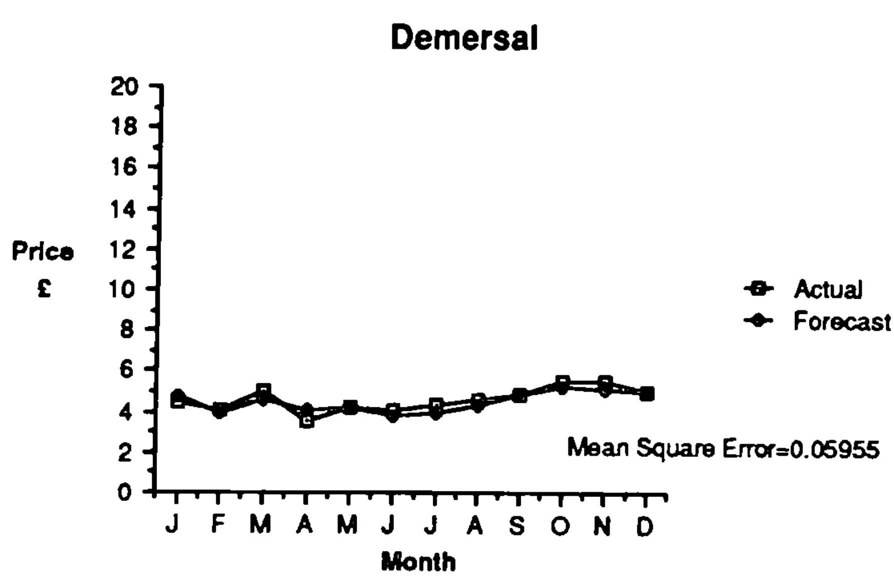


Figure 12



MONTHLY BREAKEVEN GRAPHS

January

February

March

April

May

June

July

August

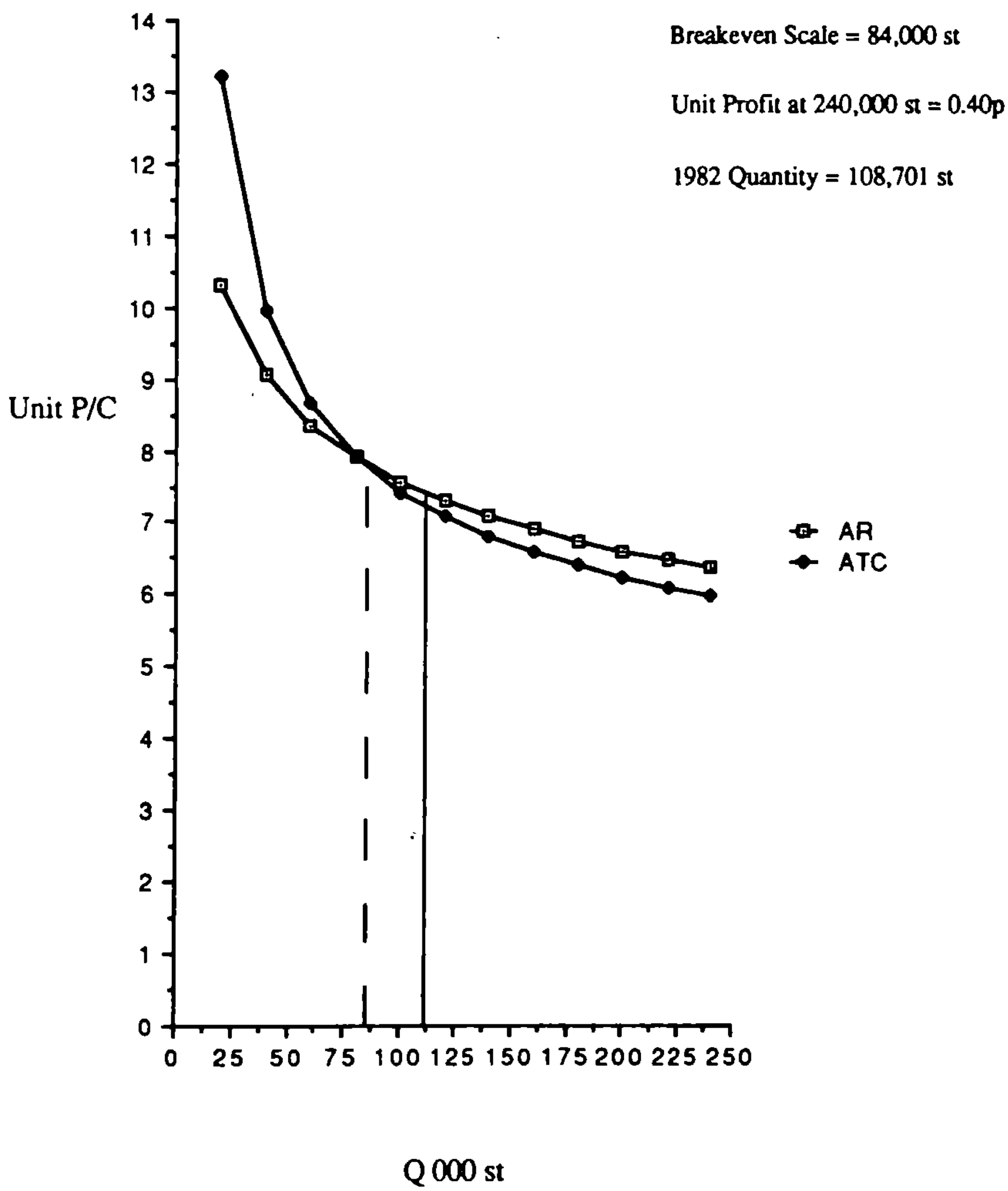
September

October

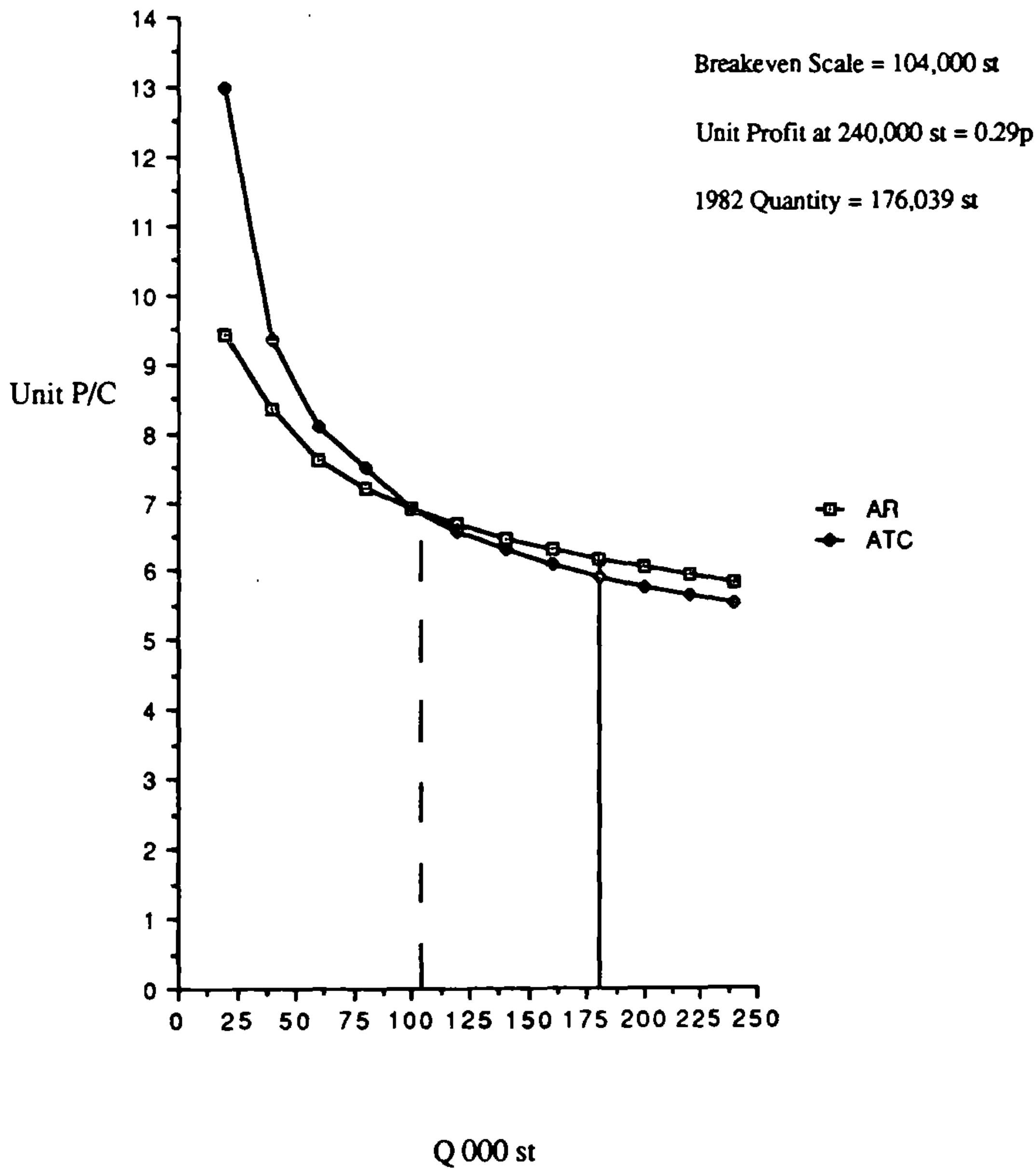
November

December

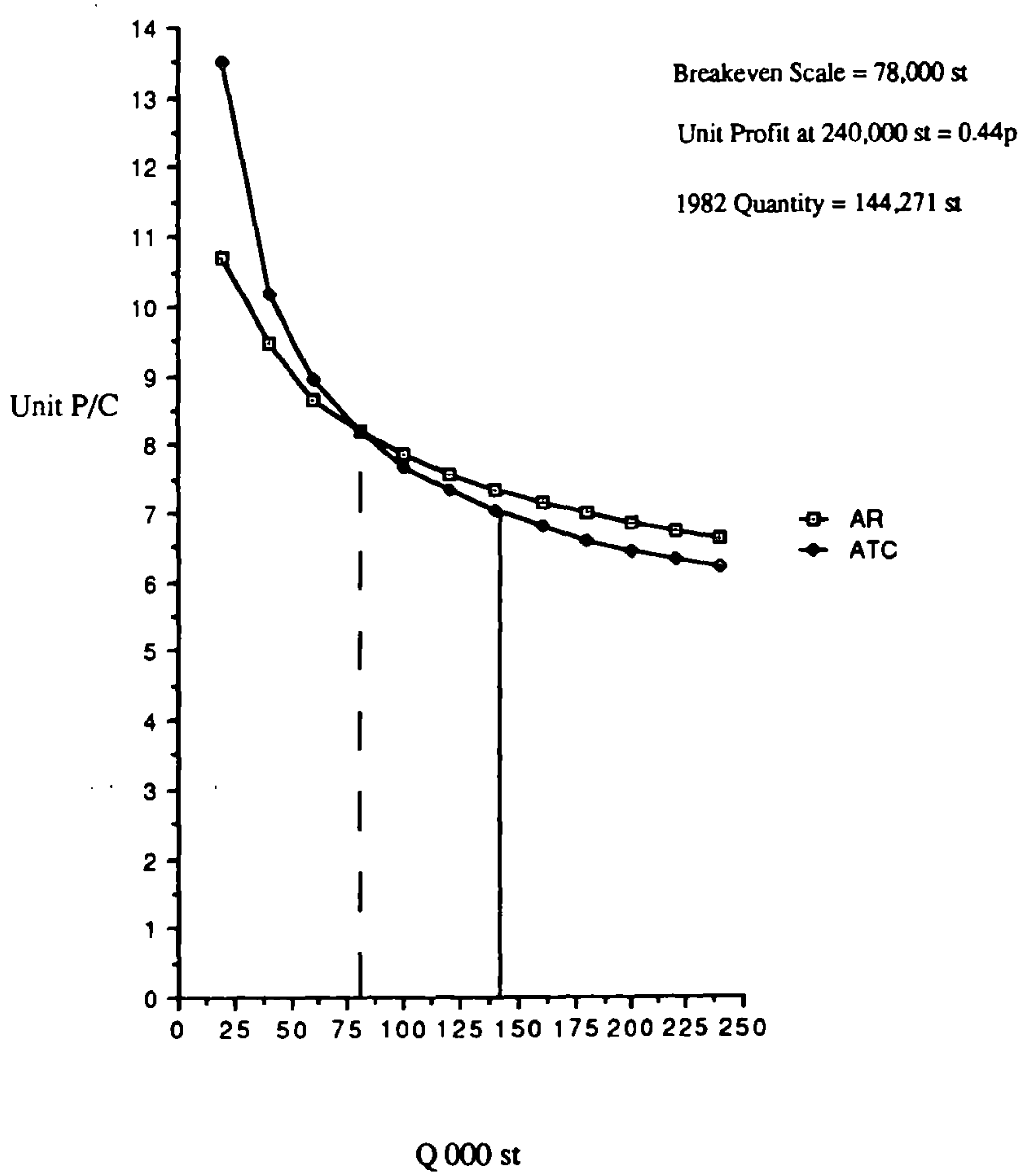
Industry ATC and AR Curves January



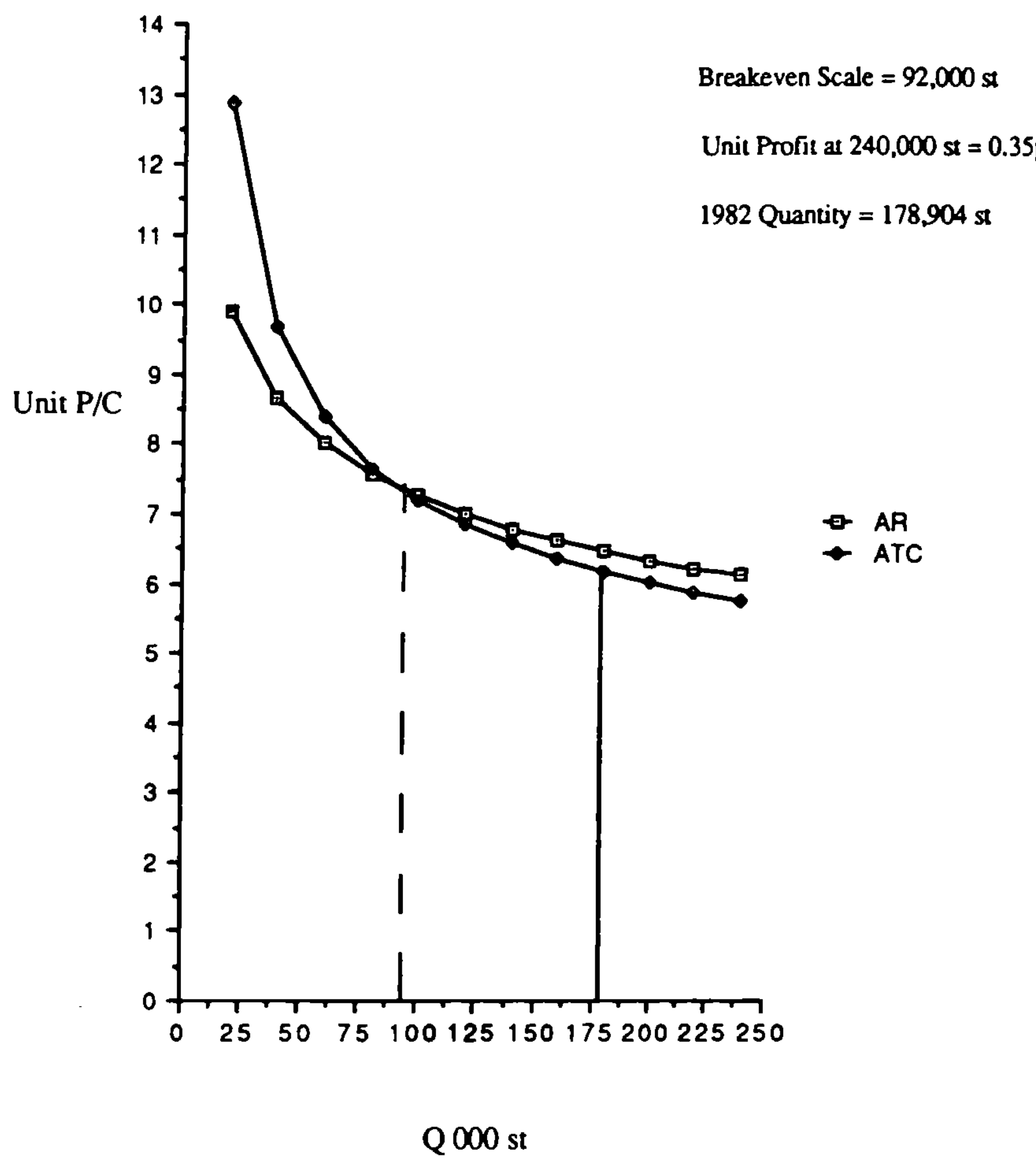
Industry ATC and AR Curves **February**



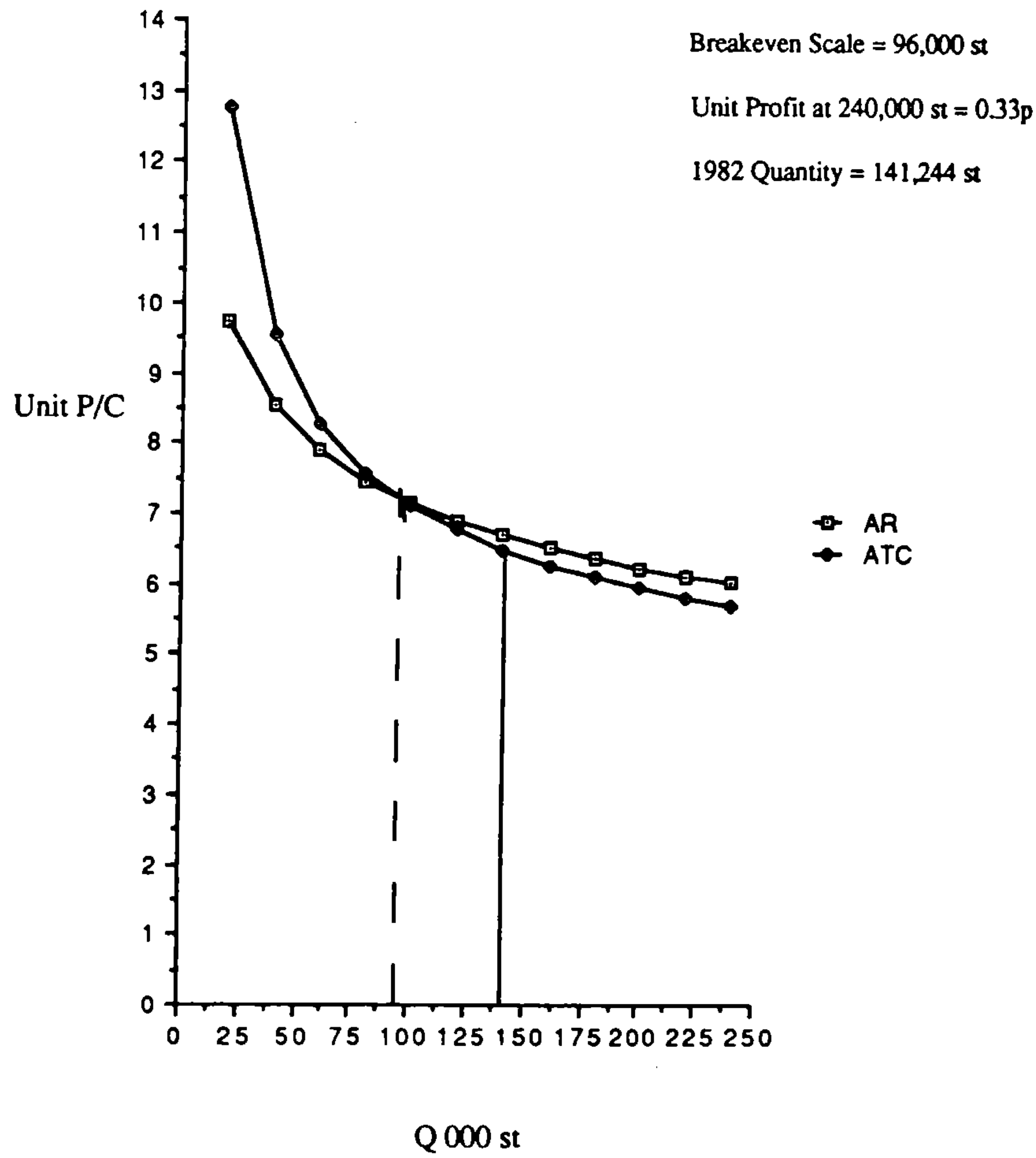
Industry ATC and AR Curves March



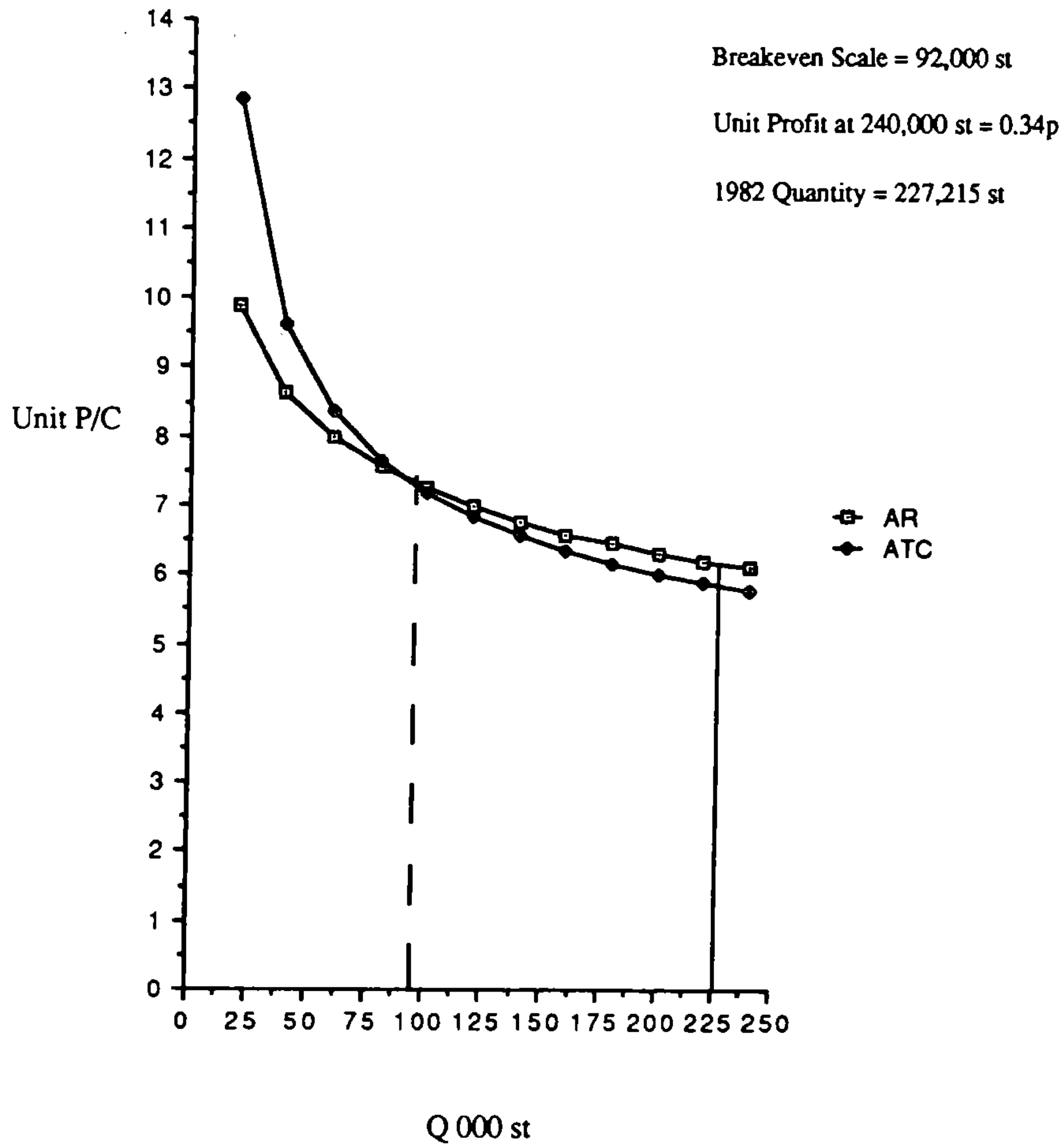
Industry ATC and AR Curves **April**



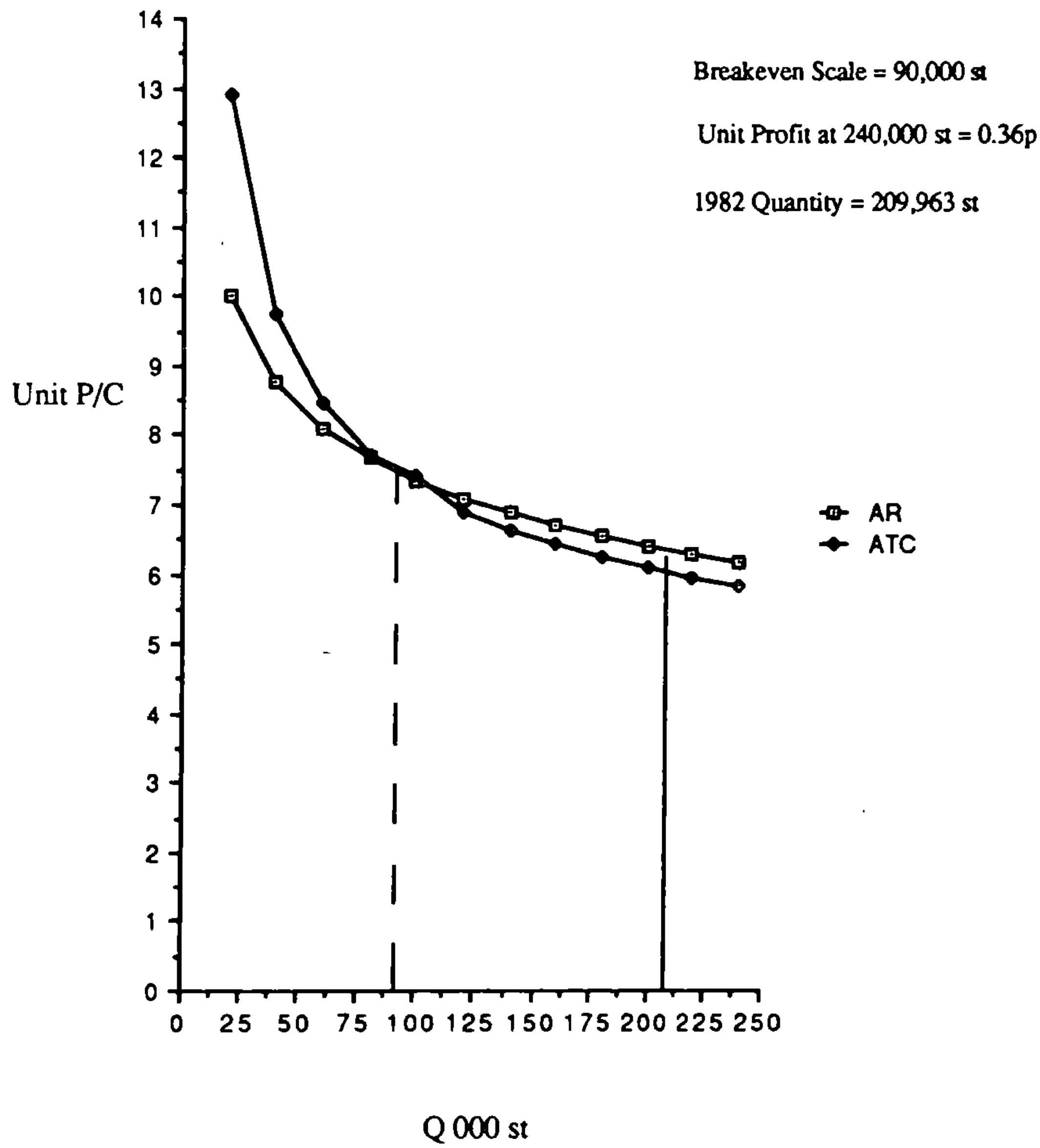
Industry ATC and AR Curves May



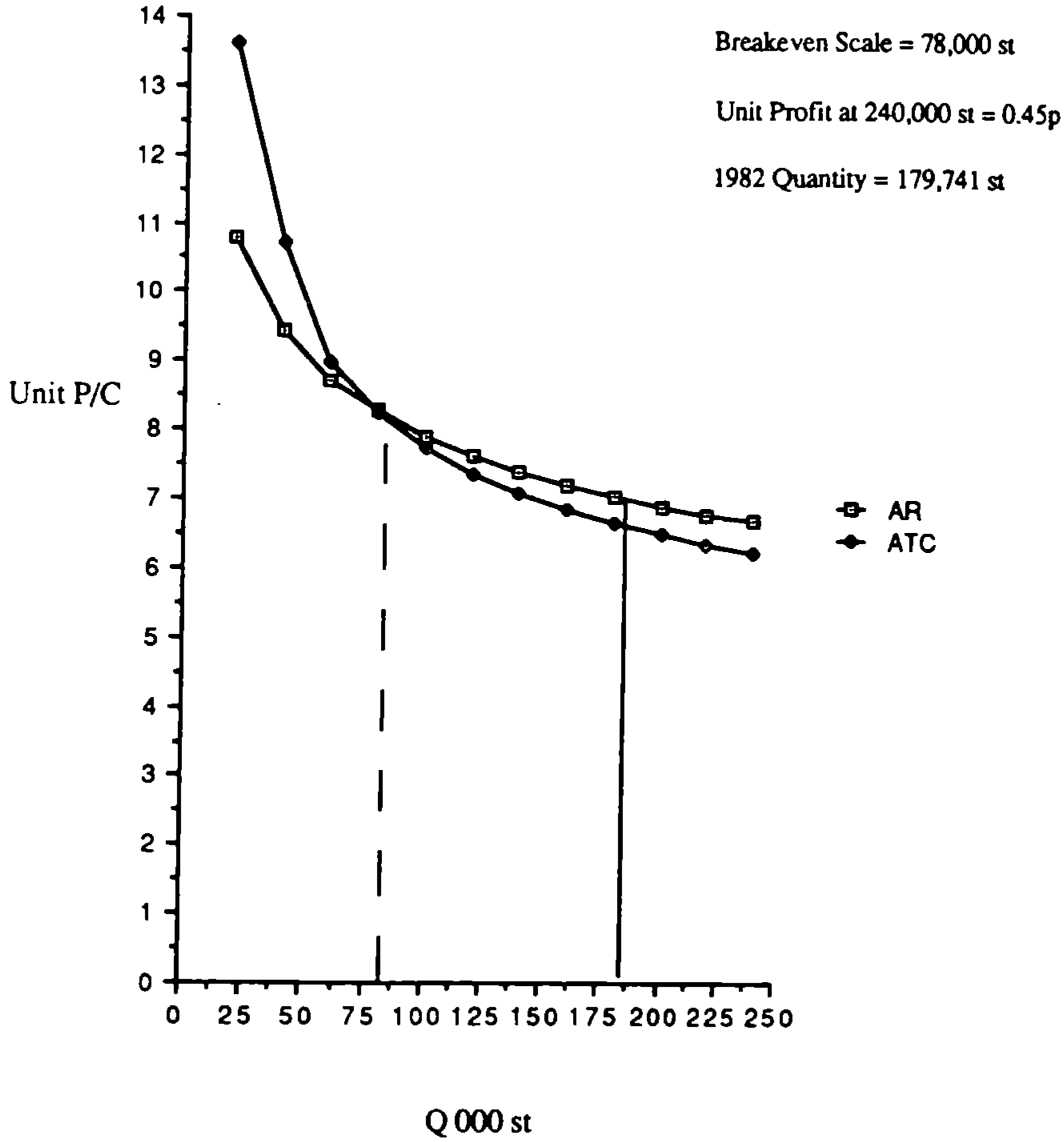
Industry ATC and AR Curves June



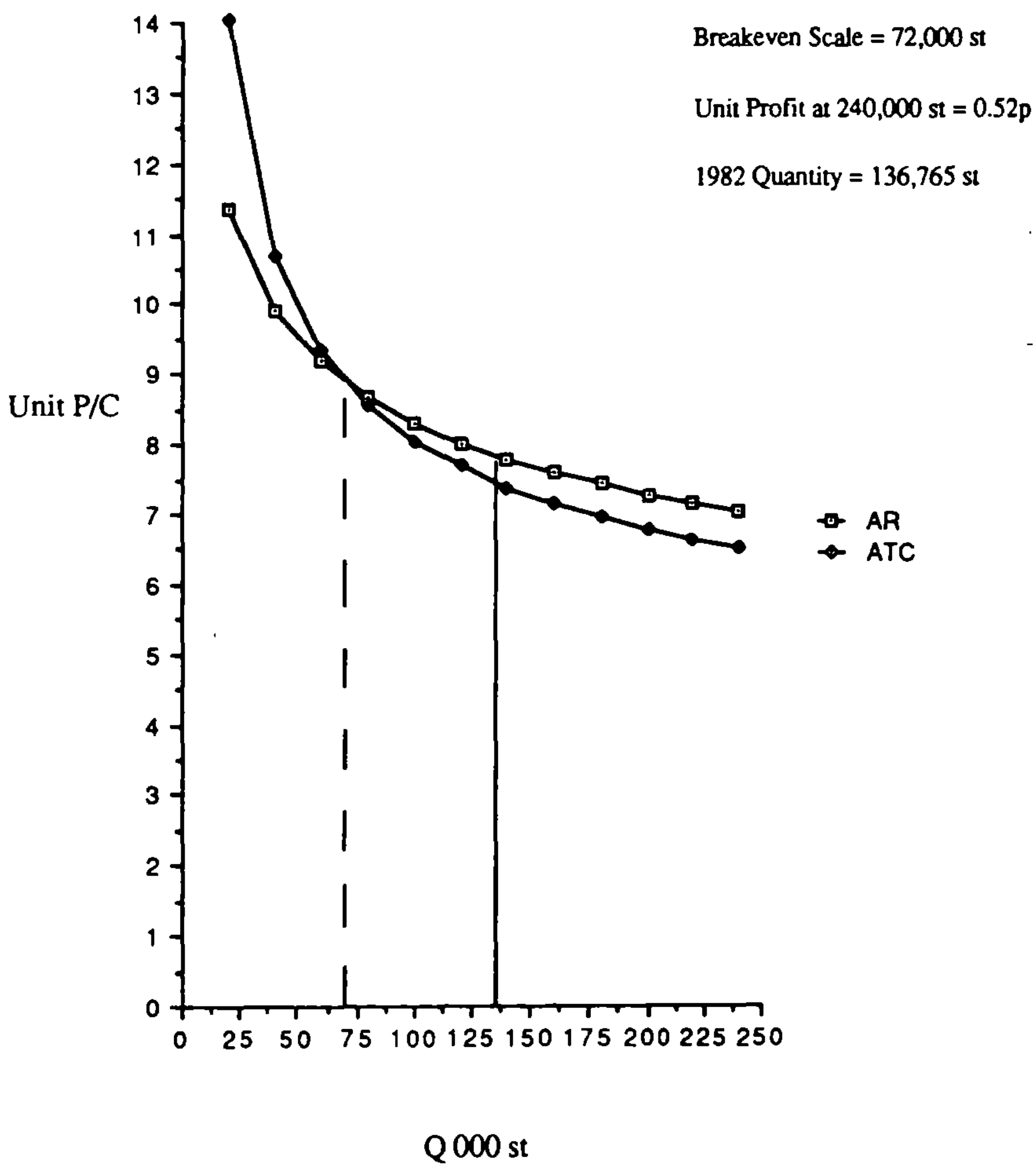
Industry ATC and AR Curves **July**



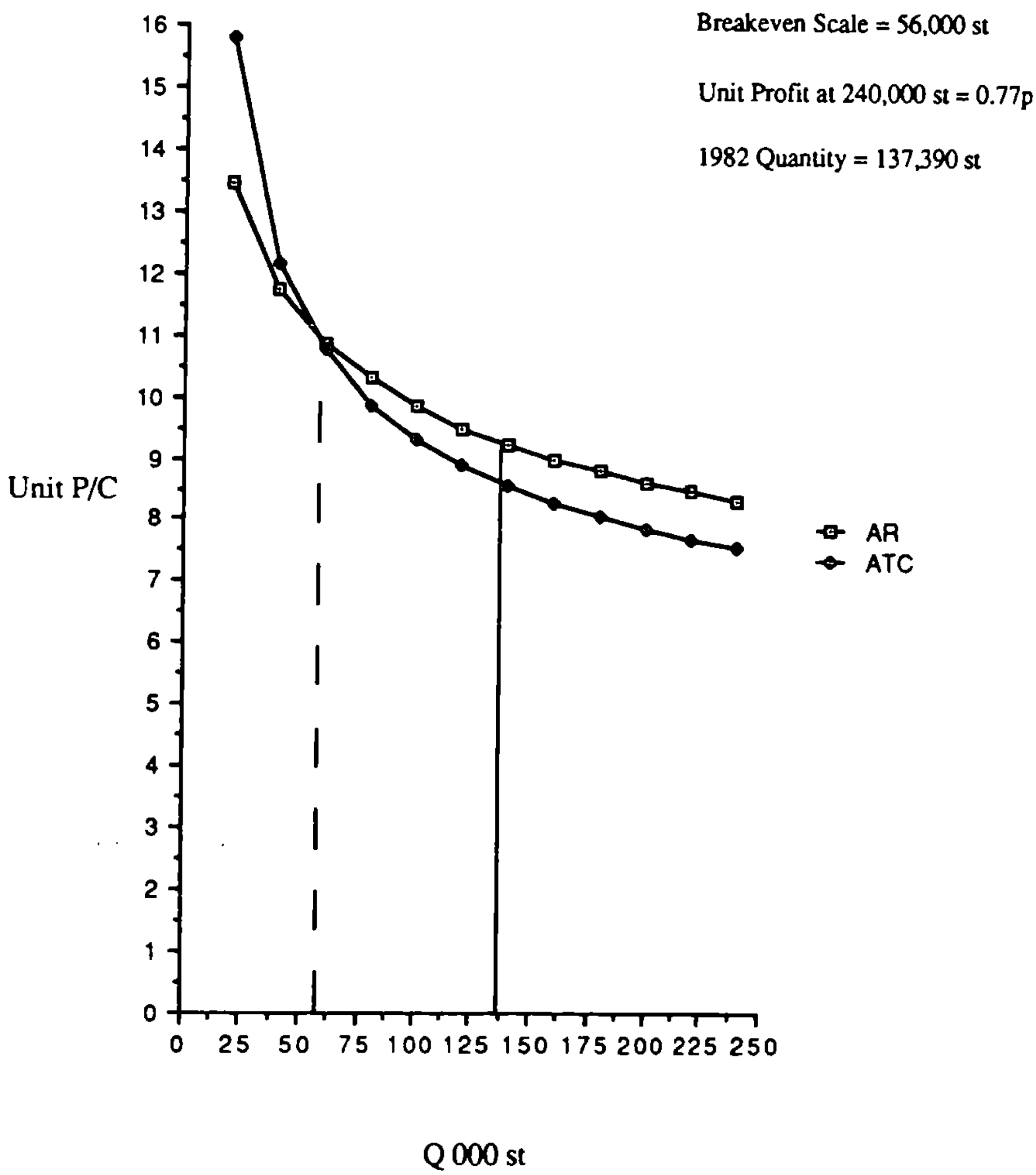
Industry ATC and AR Curves **August**



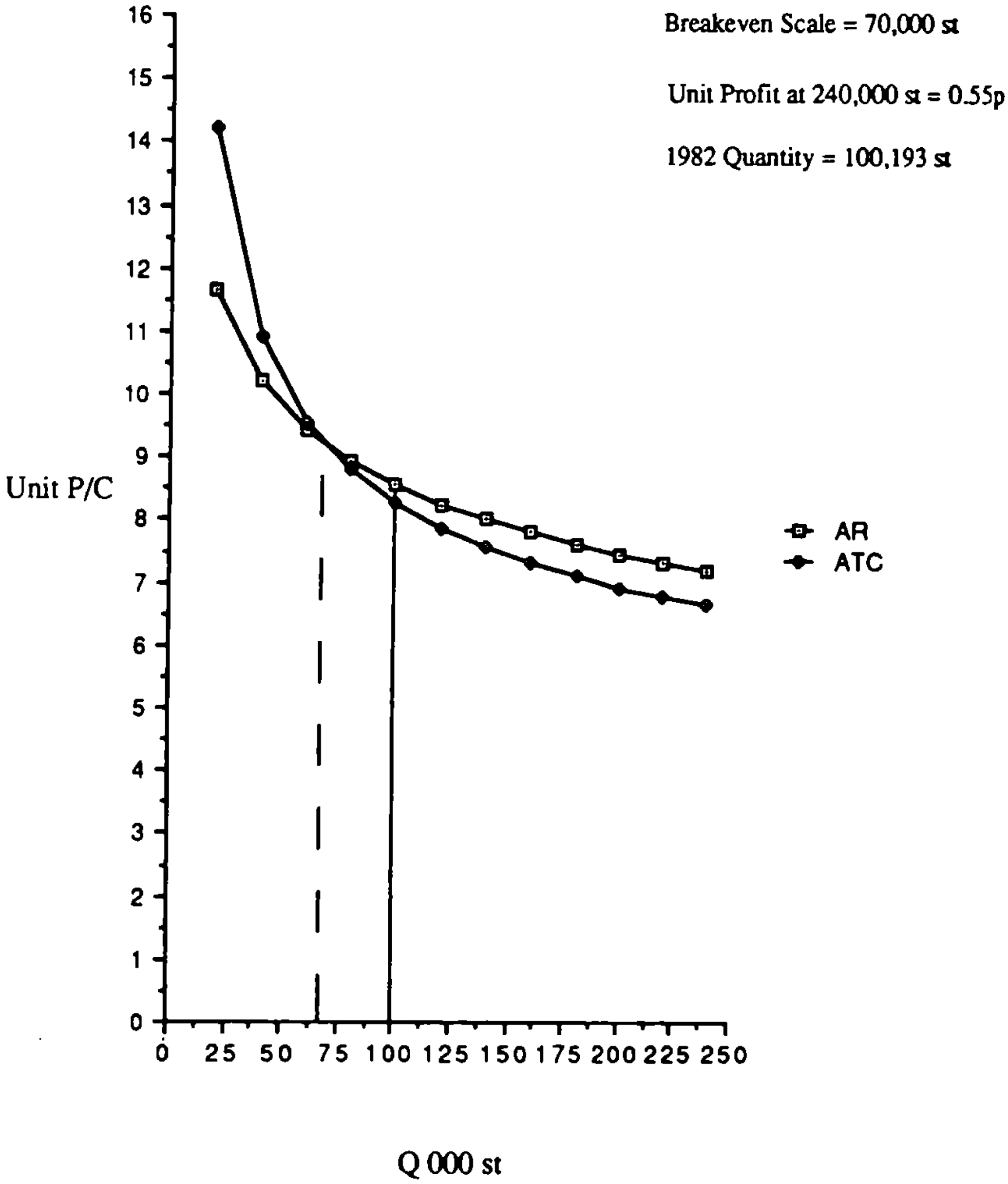
Industry ATC and AR Curves **September**



Industry ATC and AR Curves October



Industry ATC and AR Curves **November**



Industry ATC and AR Curves **December**